Rubber Conference, Brussels, 1924.

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THE

RUBBER CONFERENCE,

BRUSSELS, 1924.

BEING

THE OFFICIAL REPORT

OF THE

INTERNATIONAL RUBBER CONFERENCE

HELD IN BRUSSELS IN APRIL, 1924,

TOGETHER WITH THE

PAPERS READ AND THE DISCUSSIONS THEREON.

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INTRODUCTION.

Experience has shown that the International Exhibitions of Rubber and other Tropical Products provide a particularly suitable place and opportunity for the meeting of all those who are intimately connected with the industries represented in the Exhibitions, and it has become the custom to hold a formal Conference at which papers on subjects of current interest written by men admittedly masters of their subject are read and freely discussed. Delegates from different parts of the world are enabled to express their opinions and detail their experience, and this free interchange of views, facts and ideas has been the means of adding materially to our knowledge of the subjects discussed, widening the outlook on the agricultural resources of tropical countries, in addition to very real but intangible benefit which arises from personal contact and discussion.

The Conferences at the Sixth International Exhibition of Rubber and other Tropical Products, Brussels, which was held from 1st to 16th April, 1924, were divided into four sections, viz. :—(1) Rubber; (2) Cotton and other fibres; (3) Vegetable Oils; (4) Belgian Congo.

Professor Edmond Leplae, Director-General of Colonial Agriculture, Brussels, and Sir Wyndham R. Dunstan, K.C.M.G., LL.D., F.R.S., acted as joint Chairmen. The organisation of the Rubber Section of the Conference was entrusted to the Rubber Growers' Association, the Sectional Chairman being Mr. P. J. Burgess, M.A., F.C.S., with Sir Stanley Bois as Vice-Chairman.

To make the Conference as comprehensive as possible the Association invited representatives of the Producing, Manufacturing and other branches of the Rubber Industry to contribute Papers.

The response from the Producing side of the Industry was whole-hearted and gratifying, and The Rubber Association of America forwarded papers, but it is much to be deplored that the organisations representing the Manufacturing and Distributing branches in the United Kingdom did not contribute Papers relating to those branches. This abstention is all the more regrettable in view of the fact that there are a number of subjects on which their views would have been welcomed by pro-

ducers and from the open discussion of which it is felt that good would have resulted.

A perusal of the papers incorporated in this publication, together with the verbatim reports of the discussions which followed, will convince the reader of the high standard and excellence of the material submitted.

The Association tenders its sincere thanks to the authors of the various papers for the great trouble they have taken in preparing such papers, and so contributing to the success of the Conference and a realisation of its aims.

P. J. BURGESS.

July, 1924.

OPENING OF THE INTERNATIONAL CONFERENCE.

WEDNESDAY, 2nd APRIL, 1924.

The Sixth International Conference was held in the Hall du Cinquantenaire, Brussels, the proceedings being formally opened on Wednesday, 2nd April, at a combined meeting of delegates. Among those present were: M. Henri Carton (Minister of Colonies), Sir George Graham (British Ambassador), Prof. Edmund Leplae (Director-General, Colonial Agriculture, Brussels), Sir Wyndham R. Dunstan, K.C.M.G., LL.D., F.R.S., Mr. P. J. Burgess, M.A., F.C.S. (Chairman, Rubber Growers' Association), Sir Stanley Bois, and various delegates from Great Britain, Belgium and Belgian Congo, Brazil, the French Colonies, and the Netherlands Indies.

M. Edmond Leplae (Director of Agriculture, Brussels) said: As joint chairman with Sir Wyndham Dunstan of these meetings I feel it my duty to express my sincere thanks to the managers of this Exhibition and to all the members of these International Conferences. The result of our efforts is certainly quite satisfactory. The number of papers is about sixty, and there is no doubt that our knowledge of tropical agriculture will be greatly increased by these meetings and the discussions following. We Belgians are still very young in that extensive and difficult field of Colonial enterprise, and we are deeply grateful to our foreign friends who come here to put before us some of their experience in tropical matters. We have done our best, and we are glad to show you some of the results obtained in the Belgian Congo, but we hope that, acting on your advice and following your experience, we shall still be able to do better in the near future.

M. Leplae then repeated his address in French.

M. Henri Carton (Minister for the Colonies, Belgium) drew attention to the great efforts put forward by Belgium in order to insure the development of her African Colonies. It was necessary to make use of every opportunity for learning more of the complex nature of Colonial development. He tendered his sincere thanks and congratulations to the organisers of the Rubber Exhibition and the International Conferences, and stated that the magnificent exhibits so well displayed of the plantation products and of the natural wealth of tropical countries provided convincing testimony to the brilliant results of the great effort

exercised in these tropical regions, of which the Members of the Conferences were the most active workers.

Sir WYNDHAM DUNSTAN, K.C.M.G., LL.D., F.R.S., said: Before I proceed with what I intended to say on this occasion I am sure you would wish me to express our thanks and appreciation of the presence here this morning of the Minister of the Colonies (M. Carton), and particularly of the address that he has just delivered.

I gladly accepted the invitation of my Belgian colleagues that I should preside at the Conferences which are to be held in English in connection with the Sixth International Exhibition of Rubber and other Tropical Products. As it is essential that these Conferences should be short, I think it will be convenient that I should make any general observations at the opening meeting now instead of at each of the Conferences on particular subjects.

The meetings in French are under the presidency of my friend and colleague, Mr. Edmond Leplae, whose work for Belgian tropical agriculture has long had the admiration and esteem of his English confrères. It is with Mr. Leplae that the excellent idea originated of having on this occasion separate conferences in French and English at such times that we shall be able to attend either or both.

In opening these Conferences to-day I may recall the last occasion on which I was at Brussels for the International Congress of Tropical Agriculture, held under the auspices of the International Association of Tropical Agriculture in 1910. On that occasion I gave an account of the cotton cultivation of the British Empire and of the World, a subject which still is of the first importance, and is now to be discussed by Mr. Himbury, of the British Cotton Growing Association.

The International Association did me the honour at the Brussels meeting in 1910 to elect me its President, and in that capacity I presided over the International Congress held in London in 1914, when a further account of the progress of cotton cultivation was presented.

Taking the two most important tropical industries represented at this Exhibition, rubber and cotton, it is interesting to contrast their position in 1910 with their position at the present day.

In 1910 plantation rubber was exciting much interest as a comparatively new cultivation of great commercial promise, but then in small supply. In that and in succeeding years the price of rubber rose to 10s. a pound and over. New planting enterprises were extensively developed in the tropics, apparently on the assumption that the demand for rubber would be unlimited. In 1924 we find rubber selling at 1s. a pound or less, and the production in British countries, as well as in some others, restricted by legislation, a procedure which is, I believe, without parallel in the recent history of the production of the British tropics.

Rubber is one of the most important subjects with which this Exhibition is concerned, and is to be the subject of a number

of important papers at the Conferences by those prominently connected with the rubber growing industry and the Rubber Growers' Association. I will only now remark, as one who has from the first been greatly interested in this important industry, that apart from advantages to be derived from legislative action which, after all, can only be temporary and transient, two aims have to be steadily pursued. One is to improve and cheapen the cost of production, and the other is to improve and extend the usage of rubber for commercial purposes of all kinds. With regard to the first of these, experimental work in the tropics is essential, and this work should be carried out by qualified men in close co-operation with representatives of the producing industry. To this co-operation I have always attached the highest importance.

The Rubber Growers' Association has done and is still doing both in Ceylon and Malaya a great work in this direction, of which some account will be given at these Conferences. The Ceylon Rubber Research Scheme and the projected Rubber Research Institute in Malaya provide a satisfactory means of carrying on experimental work on the lines required.

Apart from this applied science, there are other problems which need to be dealt with by the proved investigator in a different region, and of these none is more important or more pressing than the study of rubber formation in the latex and of the nature and properties of the latex itself, of which even now we know so little. This problem needs attack both by chemists and vegetable physiologists. It is one of immense complexity and difficulty, which can only be properly attacked in the plantations in the tropics. It cannot be doubted that it holds the key to the economic and effective production of commercial rubber in the future.

The second important direction of work is for the improvement and extension of the commercial uses of rubber. In this work the manufacturer and his technical experts can render great assistance to a subject which is of much importance to him as well as to the producer. Here again the Rubber Growers' Association has taken effective action and several new uses for rubber are being developed and are illustrated at this Exhibition, still leaving, however, a wide field open for further invention and ingenuity.

Referring to the other principal product, cotton, its position as compared with 1910 is almost exactly the reverse of rubber. Production is still behind consumption, and prices have risen so considerably as seriously to restrict the manufacturing industry. In 1922-23 British imports of raw cotton were less than 60 per cent. of the figure for 1913, whilst the price was double or more. Efforts have been made and are still being made to extend cotton cultivation in the British Empire. Much success has been achieved and, as Mr. Himbury shows in his paper, there are good prospects of very substantial increases, especially in the Sudan and in West and East Africa. From both South Africa and Australia, where the prospects are to be described in a paper

by Mr. W. H. Johnson, there is promise of considerable contributions. All this, however, will take years to bring to fruition, and in the cases of South Africa and Australia any great fall in the price of raw cotton may cause a serious set-back.

As matters stand at present, the British Empire contributes less than 5 per cent. of the amount of raw cotton used by the British manufacturer, and is not likely to add much more for many years to come. The present outlook for production, together with the high price of raw cotton, are serious matters not only for Lancashire, but directly or indirectly for the entire world. Whilst quantity is likely to diminish, quality also appears, in some countries at least, to be diminishing, and Mr. G. C. Dudgeon will discuss this important question in its relation to Egyptian cotton.

Whilst continuing and increasing our efforts to stimulate further production within the British Empire, the very grave position calls for concerted action to increase cotton growing throughout the world. This is not the occasion to discuss the question in detail, but it may be pointed out that there are several countries which in this connection deserve serious attention. South America, and especially Mexico, Peru, the Argentine, and Brazil, seem to be capable of adding very largely to the world's supply of raw cotton, and the same is true of China. Before the war, in an official report, I drew attention to the excellent opportunities which offer in several districts of Asia Minor and especially in Cicilia for the growth of good average American cotton. The same is true of Turkestan and other districts in Trans-Caucasia. Now that a more promising form of Government exists in Turkey, anxious to obtain external help in developing the great potential resources of that country, it is desirable that the question of cotton growing in Asia Minor should again be dealt with.

International discussion of the problem of the cotton supply of the world is needed, and the International Association of Tropical Agriculture, in co-operation with other organisations, could probably best deal with the subject.

I may briefly refer to some other matters which are to come before these Conferences. The production of palm oil, and especially edible palm oil, is of much importance to British, French, and Portuguese West Africa, as well as to the Belgian Congo, whilst in recent years British Malaya and the Dutch East Indies have taken up the cultivation of the African oil palm in plantations with very encouraging results. New developments in the industry are awaited in several directions, particularly in improving collection and preparation. Mr. Lewis Smart is to describe the position as it is to-day in British West Africa.

Great interest is being taken in the increased production of fibres suitable for cordage. Dr. Goulding, of the Imperial Institute, will describe the Sisal hemp industry, one of the most important, especially in view of the gradual diminution in the production of New Zealand hemp owing to the employment of

the land in New Zealand for pasture and other more remunerative purposes.

Lastly, there is the subject of cocoa production, where the position is that there is an increased demand for the lower grades and a smaller demand for the higher grades. The largely increased output of medium and lower grades, particularly in West Africa, has led to low prices, a matter which seriously concerns even the native producers in the Gold Coast and Nigeria, but more particularly the growers of higher grades in Trinidad and Ceylon. Mr. Whymper summarises the position in a paper he is contributing. It is clear that unless the demand for cocoa as a beverage can be greatly increased, or the general public demand the superior qualities of plain chocolate instead of chocolate sweetmeats in which the chocolate flavour is of secondary importance, the growth of the higher grades of cocoa in South America and Ceylon may cease to be remunerative.

Owing to the war and subsequent international complications the work of the International Association for Tropical Agriculture has been brought largely to a standstill. The time has now come when its organisation will have to be reconsidered, as there is the need again for international conference and work in tropical agriculture. The opportunity may occur during these Conferences, at which representatives of so many nations are present, for the members of the Association to consider this question.

Appreciating as I do the great value of international exhibitions and conferences, in which producers in the Tropics and manufacturers and users at home are concerned, I trust that the present Exhibition and Conferences, both in French and English, will be productive of closer understanding and action for a common purpose, which is to make the manifold resources of the Tropics available for the benefit of the entire world.

After M. Edmond Leplae had responded briefly to the addresses given by M. Carton and Sir Wyndham Dunstan, he declared the Conferences open.

PRESENT AND FUTURE PROBLEMS OF THE PLANTATION RUBBER INDUSTRY.

By P. J. BURGESS, M.A., F.C.S.

(*Chairman Rubber Growers' Association.*)

The CHAIRMAN (Mr. P. J. Burgess) said: I have been asked to begin our proceedings by reading the following paper on "Present and Future Problems of the Plantation Rubber Industry":—

Looked at broadly, problems and difficulties may be classified into two main divisions, those of the physical and the psychological.

In the former group come all questions concerning man's relation to external matter, and in the latter category are all problems which involve the human element—hopes, fears, passions, prejudice and greed, but selfishness very seldom.

With the large and important industry of rubber growing these two groups of problems are clearly defined. On the one hand we have the physical problems of cultivation, selection of strain, type, and quality and quantity of yields, systems of tapping, manures, disease, chemistry of latex and rubber, transport and packing problems. On the other hand, we have the problems which arise from the clash and interplay of human factors, when we consider methods of marketing, organisation, combinations of interests, and most acutely of all when endeavour is made to make masses of men look at any particular set of facts from one point of view. Just as different physical causes and forces produce different results upon a single individual, so do the same physical causes and forces produce very different results when acting on different individuals. The same facts will not result in the same conclusions when passed through the psychological mill of differently constituted individuals.

For this reason, it is much more likely that success will attend efforts to solve the physical rather than the psychological form of problem, and it explains the greater ease of international co-operation in problems of that character.

With this brief preface I propose now to consider some problems which appear to me to call for examination and solution by those interested in rubber.

CULTIVATION PROBLEMS.

Under the heading of *Manuring*, there are a number of obscure points in connection with the relation of the character of the soil, both physically and chemically, to the growth of the *Hevea*

Brasiliensis, and, what is still more important, to the development of the latex cells and latex yields.

In Malaya manures have never been accepted as of economic value. In Ceylon to manure rubber trees has been the practice for fifteen years when maximum yields have been required. Recently in Java some strict experiments have been carried out showing that manures—particularly nitrogenous manures—exert an active influence on the development of latex cells. The whole subject needs more investigation under varying conditions, and I consider that the results will well repay time, money and labour spent upon it.

On selection of seed and vegetative propagation volumes have been written during the last five years, and we are only now just commencing to see the results of definite experiments started some six years ago. We have seen the stage of hesitating doubt in the utility of seed selection and choosing seed from heavy-yielding parent trees, of budding slips from such trees on selected seed stock—we have seen that give way to enthusiastic support. Wild and exaggerated forecasts of yields possible from such budded trees have been made, but lately the swing of the pendulum has been reversed, and now budding is inclined to go out of favour, as the results to hand tend to show great irregularity, unaccountable and disappointing. Where does the truth lie hidden? To find this out is a problem for the future.

In the use or misuse of cover plants and green manures there is accumulating a mass of information, and leguminous cover-plants which are also green manures are now available for young, middle-aged, or mature plantations with varying conditions of shade. A handy volume dealing with this subject, bringing all the facts at present ascertained into clear focus, would be welcomed by the planting world, and is a piece of work waiting for some student with a taste for literary compilation.

Disease Problems.

Diseases and pests of rubber trees, as of human society, are always with us, bred of poverty and neglect, but, like similar troubles of humanity, subject to control in the light of scientific knowledge of their causes, mode of incidence, and development.

When in future years the story of the growth of the plantation rubber industry is told, I believe that the foresight and zeal with which the problem of disease of the trees has been met will be one of the undimmed features of that tale. It is pleasing to be able to record the spirit of co-operation which has inspired all interested in the fight against the common enemy, and though, as is always liable to happen, the financial burden of research has been carried by the willing minority, we—I speak for the British growers now —must recognise that in this case the Dutch growers have fully borne their share.

The particular danger which must never be lost sight of is that arising from the increasing concentration of one form and species of tree in a limited area, and in consequence the increased facilities for the rapid dissemination of disease in an epidemic form. There is also the high probability of development of strains of plants

which have lessened natural resistance to diseases owing to the elimination of the acid test of disease itself by improved sanitation and disease prevention. This check to the free working of the principle of survival of the fittest must tend towards, and may in the future actually lead to, the survival of the unfit, with a dangerous liability to epidemic outbreaks of disease, with excessive mortality therefrom. An actual reversal of procedure may in the future become necessary, and it may conceivably become necessary to segregate experimental areas where disease can and will be disseminated and allowed to attack the trees in order to select a resistant or partially resistant strain of parents from these few individuals which prove able to survive disease conditions.

Under the heading of *Latex*, the problem of the real function of latex in the life of the rubber tree seems to be very little nearer solution than it was twenty years ago. The one outstanding fact which has been ascertained would appear to be that excessive tapping leads to liability to the disease known as brown bast. Whether this is due to excessive removal of latex or of bark, or of both combined, is not yet decided, and until the precise function of the latex is settled we can have no master-key to the problems which are associated with its removal.

Transport and Packing.

It cannot be truthfully asserted that all difficulties in the transport of rubber from the plantations to the mills are yet overcome, or that the ideal form of packing has been evolved.

There have been many complaints on the presence of extraneous matter being found in rubber, from the earliest days, when the only source of supply was wild rubber from South America and Africa. In those " happy days " dirt and gross impurity were the rule and not the exception.

With the advent of European-controlled plantations and careful preparation of rubber, it was expected that a very high degree of mechanical purity of the dry rubber would be attained, and such has proved to be the case. The samples on exhibition here are in no sense exceptional specimens, but they fairly represent in cleanliness and freedom from grit, bark, chips of wood, or other extraneous matter, average specimens of plantation rubber as it is prepared on the majority of European-controlled estates in the East. That this purity and freedom from contamination is not always maintained up to and into the manufacturer's factory is, I fear, quite proved, and the problem of how to prevent this subsequent contamination is one on which both producers and manufacturers have concentrated some attention.

It is certain that the trouble arises from two sources—firstly, from the cases themselves in which the rubber is packed being liable to shed splinters and slithers of wood during transit; and secondly, from the dirt and splinters picked up by the rubber after the cases have been broken for sampling, or by too rough handling in transport.

The suggested cure, which is still in the stage of experiment, is to wrap the contents of the cases in a plain wrapping-sheet of rubber, and in this way protect the bulk of the contents of the

cases from loose material which may otherwise find its way into the bulk of the rubber inside the case.

Shipment of rubber in the form of preserved latex which can be strained through sieves as and when it is required for conversion into coagulated rubber would eliminate this trouble arising from transport, constitutes one of the minor arguments in favour of the shipments of rubber in this fluid condition.

Another problem which is not yet acute, but which is beginning to be felt and which will in the future be of increasing importance, arises from the small size of many of the units of the producing community. The tendency throughout the civilised world is towards the aggregation of interests into large units. The old proverb about union being strength is as true with highly organised business as it is with primitive peoples, and the increase in the number of associations of all kinds connected with the industry reveals the gregarious, if not the affectionate, tendency of rubber growers.

It is, in fact, no mean feat of memory to carry in one's head all the various titles and designations of the many planters' associations—in the East in Malaya, Ceylon, and Dutch Indies, and in the West in London and the Continent. In spite of all these associations, the essential of unity is often missed, in that there is only a weak voluntary bond uniting those associated, and the executives of the various associations can only act and speak for the associations themselves, and not for the members who are associated.

In the event of united action being desired, it is necessary to obtain written undertakings and/or agreements, in order that authority can be exercised, while majorities have no power of compulsion over minorities. I cannot help feeling that one of the biggest of the problems to be faced is the reorganisation of the industry of rubber growing in such a way as to avoid this dissipation of strength by sub-division of units, and to put the industry into such condition that it can, as a single unit or as a very few units, deal with matters such as price, propaganda, and production on the large and comprehensive scale in the interests of all producers.

Tendencies in this direction are clearly observable in the amalgamation of estates, of absorption of small units by larger ones, and by the unification of control through the influence of the agency houses.

Two outstanding benefits would accrue by more complete unification. The first is the added power in keeping price and production under profitable control, and the second is the freedom of market for the capital invested in the industry.

The mechanism of joint stock company undertaking is ready to hand, and may be the key by which this problem can be solved.

We have in the last year and a half seen the benefit that can come to the industry through strictly co-operative action in the case of control of production effected through Governmental control of export. Had this policy been attained by voluntary means through direct and close association of the producers con-

cerned, the effect of it would have been stronger and quicker, and the active and vociferous opposition to it on the part of manufacturing and consuming interests would have been robbed of its chief force, for it could not then have been argued that Government action had been partial by favouring one section of the community at the expense of another—an argument which has superficially some force, though on further analysis it will be seen to be unsound when it is realised that the policy was adopted in order to nurse an essential industry through a critical time and to safeguard sources of supply of rubber for the future benefit of civilisation as a whole.

Propaganda.

An instance of how combination of interests and joint action has been productive of good results to the industry as a whole is clearly shown by the activities of the Propaganda Department formed of the Rubber Growers' Association, which was called into being and provided with the necessary funds by voluntary contributions from planting companies, together with some financial assistance from the Governments of Malaya and Ceylon.

The purpose of this Department has been to increase the consumption of rubber, but in giving effect to this purpose difficulties of a special character have been confronted. Rubber in use differs from most other products in the important feature that it is not consumed by itself but as a constituent part of some other commodity, and, as a general rule, as a small constituent only.

This being so, the relation between price and quantity consumed is not a direct one, and is very slow and imperfect in action. The consumption of golf-balls is scarcely influenced by the price per pound of raw rubber, and a surfeit of rubber will not increase the sale of mechanical piano-players, though each one contains as many rubber tubes as there are notes on the scale.

The problem for propagandists who wish to increase rubber absorption is to select or invent that use of rubber which consumes rubber in bulk, which is largely independent of the cost of manufacture of other commodities with which the rubber is associated.

The use of raw rubber for soleing boots and shoes has, up to the present time, been the use which has appeared likely to respond best to stimulation.

The material itself has qualities of durability, lightness, silence, flexibility, and there is, too, a romantic feature about it which makes some appeal to the public. Rubber direct from the plantations, stuck by rubber glue direct to the soles of your boots and shoes, with perhaps a little help from a few stitches, gives an elastic spring to every walk of life, damp defying, and proving that, though there may be nothing like leather, yet rubber, in its very "unlikeness," is better, and beats leather all the time for shoe-soles. Propaganda in popularising this advance in quality of footwear has been highly successful, and, by starting with the luxury shoe and sports shoe, has set a standard higher than any held before. The next step is to bring the extension of the use of natural crepe rubber to everyday footwear, and to put it within the reach of everyone who can afford to wear boots at all. In

this direction it is essential that maximum service at minimum cost be the keynote, and there is the widest market waiting the enterprising manufacturer who first puts the low-priced general purposes boot with crepe rubber soles upon the market. To develop this side of the boot-sole problem must be the next big work of the propagandist who aims at increased rubber consumption.

There is a very real and practical difficulty in carrying out and in extending the use of vulcanised and compounded rubber ware, which arises from the diverse interests involved and the difficulty in obtaining co-operation between the producers of the raw rubber, the manufacturers of the compounded article, and the wholesale and retail distributor. The producers have for the past three years been ready and willing to co-operate with the other sides of the industry, and have made practical and definite proposals for such co-operation, and been prepared to put up substantial sums of money for development purposes. They have, however, found little or no response from manufacturing interests, and the inequity of the producers bearing the whole burden for a benefit in which the manufacturing and distributing sides would have the greater share has been too obvious for any action on such an unequal footing to result. It is deeply to be regretted that close co-operation cannot be developed and maintained. With co-operation there are many directions—for instance, floor coverings and linoleum substitutes—where there is great scope for development, with resultant benefit for producers, manufacturers, distributors, and consumers alike. Without co-operation, there is the perpetual danger of antagonism of interests which should never be opposed, and of cleavage where there should be unity.

There can be no standing still in this or any other direction. Failure to co-operate must lead to estrangement and working in antagonism.

One argument which has been frequently put forward against co-operation of producers and manufacturers is that it is not possible to have fusion of interests as between buyers and sellers, and that manufacturers' interests are in cheap rubber while growers' interests are in dear.

On text-book first principles this argument appears plausible, but it is contrary to actual experience in the rubber industry, where trouble in either the growers' camp or the manufacturers' citadel has proved bad for both; and, furthermore, the public does not appear to reap any substantial benefit from curtailed trade. Certainly at the present time there should be no apprehension of increased consumption leading to inflated prices for the raw material, owing to the presence of a large potential output waiting for reasonably profitable prices to set the collection machinery in movement.

In the event of any really new use for rubber, or an extensive development of any existing use, it might be practicable to guarantee over a considerable period of years a full supply of raw material for the purpose at a fixed figure, say at 1s. to 1s. 3d. per lb., and while Government restriction of export is in force it might conceivably be arranged that rubber for new uses in bulk

should fall outside the exportable quota provided the supply and control of such excess rubber were left in Government hands.

What is it, then, which stands in the way of greater unity and progress? Are rubber manufacturers, distributors, and retailers satisfied with the state of affairs as it now exists, with depression more the rule than the exception? Do they believe that a working arrangement with each other, with the growers and factors, for the purpose of popularising the general use of all rubber goods is not practical politics? Why should rubber not be open to benefit from combined publicity?

Rubber growers are ready and willing to do their full share of the work and carry their full share of the costs of combined development, and it should not be a problem incapable of solution to devise a way to bring all interested in rubber into co-operative harmony.

DISCUSSION.

The Chairman: The paper is open for discussion or comments, and I should like to hear any remarks members may have to make.

Mr. Cyril Baxendale: There is only one matter in connection with the very interesting and valuable paper that Mr. Burgess has just read to us on which I have a few remarks to make, and that is in connection with the reasons he gives for the chips and rubbish that find their way into the cases when they reach the hands of the manufacturers. In 1912 I thought we had begun to get over these difficulties. I was then representing the Planters' Association of Malaya in New York, and manufacturers I found were more worried about this subject than about any other subject in connection with the industry as far as we were concerned. I was taken down into the vaults of some of the largest factories there and I was shown enormous packing cases big enough to contain at any rate cottage pianos, if not grand pianos, and I was told that the rubber contained in these cases had been bought from " Highlands, Ceylon." It seems to have come from Highlands and Lowlands in the Malay States. I happened to know these estates very well, and I knew such cases had never been sent from Highlands and Lowlands or any other reputable estate in Malaya. That was in 1912. Eventually, I think I traced the difficulty to a transference of the rubber from the original cases into these extraordinary packing cases in London. The dealers had bought the rubber and shipped it out to New York. The reason given by the dealers for putting the rubber into fresh cases was that our cases were " too flimsy." They were mostly three-ply cases and I think they might splinter, but they would not leave a lot of rubbish among the rubber, as these cases certainly did.

Then we tried direct shipment, and I think I was the first to try it from the Malay States, and now I believe seven-eighths of the whole of the rubber imported into America goes direct from Eastern ports. I was rather startled about two years ago by some correspondence in the " India Rubber World " of New York, which showed that the trouble was still going on. I wrote to the Rubber Growers' Association at once, and over to America.

My letter was published in the " India Rubber World." In it I suggested that their buyers must be putting the rubber into these extraordinary cases again and that it would be a far better thing to avoid that.

I think Mr. Burgess has suggested the remedy; that is, packing rubber in rubber. If we could avoid wood altogether it would be a splendid thing. But we have one difficulty about this, and that is we have never received any indication from the manufacturers, as far as I can discover, that they would like to have rubber packed in rubber, and that in that case they would pay for the rubber wrapping. If we could only get some indication as to the desire of the manufacturers it would be extremely helpful to us.

Mr. J. G. Fol: Several Dutch rubber companies are already shipping the rubber packed in rubber and the whole block packed in a mat, and we are making propaganda for having rubber packed in mats in this way. (The speaker produced illustrations for inspection.)

The Chairman: Can you tell us whether the gross weight of the rubber, including the outside package, was treated as first quality? That is the point Mr. Baxendale made—whether the inside contents would be bought as first quality and the outside treated as scrap.

Mr. Fol: Yes, I think so, but the wrapping is only a very small quantity.

The Chairman: The only objection I can see to packing in rubber is that there might be a loss on the rubber wrapping.

Mr. Fol: I might say, too, that if the rubber is put in in a perpendicular way it would not press together.

Mr. Baxendale: Suppose we have these sheets packed in low-grade crepe, I would not ask the manufacturers to pay the price of sheet for the low-grade crepe packed round it, but I think some payment should be made for it. After all, all rubber shipped comes under our present restriction conditions.

The Chairman: Here in the Exhibition the wrapping is of the same quality as the rubber inside.

Mr. Fol: Yes, it is the same quality. It is not advisable to use lower grade for the packing.

Mr. Baxendale: I was thinking of that exhibited form of packing in 1921.

The Chairman: If there are no further comments I think we can pass on to the next paper.

ON SOME PHYSIOLOGICAL ASPECTS OF DISEASE IN PLANTS.

By V. H. BLACKMAN, Sc.D., F.R.S.,
Professor of Plant Physiology and Pathology,
Imperial College of Science and Technology, London.

The CHAIRMAN (Mr. P. J. Burgess) stated that he regretted Prof. Blackman was not present to read his paper as he felt sure those present would have enjoyed hearing it first hand. Mr. Burgess then read the paper, as follows:—

In the study of infectious disease animal and plant pathologists have made great advances during the last fifty years. In both these branches of pathology the bacteria and fungi which produce disease have been investigated, their characteristics described, and their life histories followed; the necessary foundation for further advance has thus been established. In the field of prevention and cure of disease, however, the two branches have not advanced on a parallel front. As is well known, plant pathologists have concentrated their attention in the main upon the development of fungicides for application to the surface of the plant, so as to prevent the entry into the tissues of the organism responsible for disease. To a less extent, also, the breeding of disease-resistant plants has been successfully pursued. On the animal side the question of breeding for disease resistance has naturally attracted little attention, though in the case of farm stock this avenue of advance would seem to be worth exploring. In the elucidation of the nature of disease resistance and in the study of methods of prevention and cure, the animal workers have, however, far outstripped their botanical colleagues. One need only point to the development of vaccine and serum therapy, which, originating with the work of Pasteur, now stands as one of the most striking achievements of modern biology.

The animal bacteriologists owe their attainment of the control, by serum and vaccine treatment, of such diseases as tetanus, diphtheria, and anthrax to the elucidation, or partial elucidation, of the nature of acquired immunity to disease. They have added to the study of the etiology of disease and the physiological behaviour of the parasite a scrutiny of the reactions of the host to parasitic attack—reactions which, at least in the case of man, are in general so striking that the physiological aspects of animal disease have long compelled attention.

By plant pathologists the physiological aspects of disease have, until recent years, been very largely disregarded. This comparative neglect, however, is not altogether surprising when the physiological differences between animals and plants are apprehended. The symptoms of infectious disease in man and the

higher animals are usually so highly specialised that the nature of the disease can generally be resolved without the determination of the specific nature of the parasite. In plants, on the contrary, the symptoms of parasite disease are usually "generalised," very many infectious diseases exhibiting the same symptoms; it is thus frequently quite impossible to determine the nature of the disease without a knowledge of the nature of the parasite. It must, however, be strongly emphasised that this difference between plants and animals, due to the greater complexity and degree of differentiation of the animal, is not a fundamental one. Although symptoms of many different parasitic diseases of plants may superficially be similar, yet the existence of physiological reactions of the host specific for each infection can hardly be doubted; for disease is abnormal physiology, the result of the interaction of the physiological processes of the host on the one hand and of the parasite on the other. At the present we are unable, in the majority of cases, to distinguish the special responses which the interaction of these two sets of processes must produce in plant cells invaded by a foreign organism. With improvements in our methods of biophysical and biochemical analysis we may look forward to the time when these reactions, now hidden from us, will be clearly apprehended. With this recognition of specific symptoms a classification of plant diseases based on such symptoms will be possible—a classification which would appear to be a much more natural one than that based solely on the nature of the infecting organism.

Another very marked difference between the two branches of pathology which has pushed the physiological reactions of the animal host into the foreground while relegating those of the host plant to obscurity, is that relating to acquired immunity. The immunity or resistance to a particular disease acquired by one attack of that disease must have forced itself on man's attention from very early times. As already stated, this acquired immunity and the elucidation of its nature has pointed the way to the discovery of vaccine and serum therapy, by which acquired resistance or immunity can be artificially bestowed. In plants, however, it is not to be expected that such a method of treatment can ever be available, since the necessary foundation is lacking. What is so common an occurrence in higher animal life is, unfortunately, entirely wanting in the vegetable kingdom, for no clear case is known of a plant acquiring immunity or resistance as a result of one attack of an infectious disease. The cause for this marked dissimilarity in reaction to diseases lies, no doubt, in the great physiological differences between plants and the higher animals.

The inability of the plant pathologist to bestow immunity by the injection of a vaccine or a serum is probably not such a serious loss as might appear at first sight, for the difficulties in applying such a method of treatment to the massed population in field and plantation would seem almost insurmountable. Furthermore, even if an individual plant could be so endowed with disease resistance, the condition of continued development so characteristic of the higher plants suggests that such endowment would be of little practical value. Judging by the difficulties of transmitting acquired immunity from parent to offspring in the animal, it is highly

unlikely that the later-formed organs (leaves, stems, and roots) of such a plant would have that resistance transmitted to them.

Lacking methods of artificial immunisation, the main work of the plant pathologist has been directed to the protection of the plant from attack by means of poisonous agents, and to some extent also to the breeding of disease-resistant varieties—*i.e.*, plants possessing natural immunity.

Owing to this orientation of plant pathology, the physiological aspects of disease in plants have been largely neglected. It is only of recent years, for example, that the physiological relations of host and parasite have received considerable attention. How remarkable may be the results of such a study is shown by the investigation of the nature of immunity to wheat-rust, with its almost paradoxical conclusion that there is no real resistance in the ordinary sense of the word, but " hyper-sensitiveness." The tissues are so susceptible to attack that they die almost immediately, and so bring the invasion to an end. The discovery also that plants may give off volatile substances which can accelerate or retard spore germination and infection, again shows the complexity of the physiological relations of host and parasite. There is no doubt that a more intense study of this aspect of plant pathology would bring into view many phenomena which would almost certainly be of practical importance.

Another physiological aspect of disease which is only now beginning to receive attention is that of the effect of environmental conditions on the incidence of disease. The direct effect of unfavourable external conditions—such as too high a temperature, too low a temperature, drought, water-logging of soil, etc.—in producing unhealthy growth is, of course, well known. In such cases there is a condition of disease entirely independent of the invasion of a foreign organism. In this class of diseases the brown-bast of *Hevea* probably falls, the unfavourable environment in this case being, apparently, the too-frequent applications of the tapping-knife. This disease differs, of course, from most of those produced by the direct action of the environment in the obscurity of the symptoms and its slowness in development.

The physiological question of the effect of environmental conditions on the susceptibility of plants to fungal and insect attack is still much in need of investigation. In the case of man the relation of general health to infection is generally accepted, though its importance is often exaggerated, since there are many diseases, such as typhoid fever, in which a high degree of physical health is no protection. As an instance of the want of correlation between general weakness and infection, the case of *Cystopus candidus* may be quoted. Melhus found during experimental work with this parasite that only when the plants were in a healthy condition was it possible to obtain extensive infection; unhealthy plants and those attacked by aphides could not be fully infected. The behaviour of *C. candidus* is no doubt somewhat exceptional, and there is accumulating evidence that improvements in the hygienic conditions under which plants are growing can in many cases reduce the amount of infectious disease.

The close relation between infection and external conditions is seen in the behaviour of *Fusarium conglutinans* and other species

of that genus, where the soil temperature has been shown mainly to control the parasitism of the fungus. The physiological effect of fertilisers in influencing the amount of disease is well known, and is strikingly shown in the Rothamsted wheat and grass plots. Howard has demonstrated the relation between external conditions and the parasitism of *Puccinia graminis;* with a "pure line" wheat there was much less disease with plants growing in pots than with similar plants in the field. He states also that applications to the indigo plant of green manure shortly before sowing is always followed by a severe attack by the insect *Psylla isitis*, and he finds that with *Melampsora Lini* the deep-rooted types of linseed are much more susceptible than the shallow-rooted ones. In the West Indies insufficient drainage has been known to intensify in cocoa an attack of *Thrips*. In the same plant the breaking up of a pan of laterite beneath the soil has been found to reduce markedly the amount of infectious disease. Such examples exhibit the close correlation between the physiological condition of the host and the incidence of disease.

The existence in tropical crops and plantations of physiological disease on the one hand, and on the other hand the demonstration in many disorders of the close relation between the physiological condition of the plant and the extent of infection, are clear evidence of the importance of a closer study of the physiology of tropical plants of economic importance. Apart from the question of disease, a fuller knowledge of, for example, the normal physiology of *Hevea* can hardly fail to improve production. In the absence of such knowledge optimal yields can, in fact, hardly be expected. In the presence of disease, satisfactory and economical control is, in many cases, much more likely to be realised if knowledge of the physiological relations of the host plant is available.

DISCUSSION.

Mr. BAXENDALE: I would like to say we regret that Mr. Blackman was not able to be here himself to read us this paper, because it is extremely interesting to those of us who are interested in planting and to the industry at large. As regards his views on Brown Bast and the physiological effect of tapping in that connection, my own experience of planting entirely confirms what he says. That ought to be well rubbed in, and I think it should be thoroughly appreciated by our friends of the Netherlands Indies.

The CHAIRMAN: That concludes the session for this morning.

PROPAGANDA FOR THE RUBBER INDUSTRY.

By SIR STANLEY BOIS.
(*Convener Propaganda Committee, Rubber Growers' Association.*)

Mr. P. J. BURGESS, who presided, said: Sir Stanley Bois is well known to you all and needs no introduction from me, and so I will at once call upon him to read his paper on "Propaganda."

Sir STANLEY BOIS: The Rubber Industry is one of the great basic industries of modern civilisation. Rubber is an indispensable servant of mankind. To-day more than 30,000 different articles are being made from rubber. We who are directly interested in the rubber industry are cognisant of the properties of rubber, and most of us realise the potentialities of the development of the applications of rubber. If, however, consumption of rubber is to be increased, it is obvious that the consuming public must be fully informed as to the actual and potential uses of rubber. That is the purpose of propaganda for the rubber industry.

No one would suggest for a moment that we have approached anywhere near the saturation point in respect of the consumption of rubber. There is undoubtedly a great field of activity for educational work. The general public are by no means aware of the existing potentialities of rubber, and even the other great industries of the world are not fully alive to those potentialities. To my mind, the ideal form of propaganda for the rubber industry lies in the direction of the development of an international co-operative educational publicity which will convey to the people of every nation a full knowledge of the properties of rubber and its manifold applications.

The Rubber Industry comprises many interests. The producers, the crude rubber merchant, the manufacturer, the distributor, and the retailer of manufactured rubber goods are all directly interested in an increased consumption of rubber, and each and all would ultimately benefit from a co-operative publicity movement. I realise fully the great amount of organisation which will be necessary in order to develop an international campaign, but I do not believe that such a campaign is beyond the bounds of possibility. The Rubber Industry is rich in associations and other organisations representative of the various spheres of activity, and these organisations would appear to be the media for the development of co-operative action. It would be impossible in the scope of this paper to give any details of actual schemes for the co-ordination of the activities of these organisations. I would, however, emphasise the potentialities of propaganda, and, as an example of what propaganda can accomplish, I should like

to draw attention to what has been accomplished by the Rubber Growers' Association in that direction.

Prior to the formation of a special Propaganda Department in 1921, the Rubber Growers' Association had carried out a certain amount of propaganda work. The International Rubber Exhibitions, which commenced in 1908, afforded a most valuable means of demonstrating the merits of plantation rubber. The 1912 Exhibition was held at New York, and was a means of bringing plantation rubber directly to the notice of important manufacturing organisations in the United States and Canada. The Exhibition in 1914 was particularly noteworthy, inasmuch as actual demonstration was afforded as to the value of plantation rubber in the manufacture of tyres. Prior to the Exhibition arrangements were made for directors of producing companies to supply plantation rubber to manufacturers in Great Britain to be made up into tyres. These tyres were then distributed for testing by actual use, and a large proportion were returned for exhibition, and details of mileage, etc., were given. The experiments furnished definite data and convincing proof that plantation rubber was equal to Para for the purpose of tyre manufacture. Tyre manufacturers, prior to the tests initiated by the R.G.A., had shown a marked disinclination to use plantation rubber.

The 1914 Exhibition was the means of bringing together into closer contact the various interests of the industry, and manufacturers and producers of plantation rubber were able to discuss the various problems which affected their own interests. The outbreak of war interrupted the development of a closer intimacy, but during the war the R.G.A. was instrumental in bringing to the notice of the Admiralty and the War Office various suggestions for the use of rubber, some of which were ultimately adopted. The first Rubber Exhibition after the war was held in London in 1921, when a comprehensive exhibit was staged. In addition, the R.G.A. was responsible for the organisation and arrangement of the displays sent from Malaya and Ceylon. At the present Exhibition the Propaganda Department has assembled an exhibit which is designed to indicate the actual uses of rubber. This exhibit cannot, of course, be entirely representative of all the uses of rubber, but the main purpose is to demonstrate to the general public the importance of our product.

The International Exhibitions undoubtedly serve a most useful purpose from the point of view of actual publicity, but there is another most important phase of propaganda work which for some time has received considerable attention from the Rubber Growers' Association. I refer to the development of suggestions for new uses for rubber. In 1919 a fund known as the Rubber Uses Development Fund was established, as the outcome of a suggestion that the Rubber Growers' Association should offer awards for ideas and suggestions for extending the present uses, or for encouraging new uses of rubber

Over £10,000 was contributed by members and others interested in the production of rubber, and the prize competition was inaugurated.

The competition received world-wide publicity, and, as a result, over 2,000 entries, embodying about 10,000 suggestions, were

received. These suggestions were carefully examined by a board of adjudicators, and their report and award duly prepared All suggestions received, together with other suggestions forwarded to the Association from time to time, were handed over to a panel of experts, who collated the information, carrying out certain tests where necessary, and finally prepared comprehensive reports upon all the material received. These reports were issued in the form of " A Handbook on Rubber Uses and Their Development," which was distributed to rubber manufacturers all over the world, as well as others who were likely to be interested.

This handbook forms a compendium of all available information in respect of the development of the suggestions received by the Association for new uses of rubber, which uses apparently will appeal to the public, inasmuch as they have emanated from the public themselves.

Since the Competition was closed suggestions are continually being received from the general public, and, apart from any material benefits arising from the Competition, there can be little doubt that the scheme has been of immense value, inasmuch as it aroused a worldwide interest in the rubber industry and was the means of securing valuable publicity.

Another phase of publicity undertaken by the Association was the establishment of the Rubber Gifts Fund Committee. This Committee carries out functions of a charitable nature, and, by means of donations of cash or rubber generously contributed by rubber-producing companies, has been able to provide rubber flooring for over thirty hospitals and distribute nearly 7,000 rubber hot-water bottles at various times to numerous hospitals and nursing homes.

That the work of this Committee has borne fruit is shown by the fact that the provision of rubber flooring in leading hospitals, etc., has afforded opportunities of demonstrating the possibilities of the commodity, and there is ample evidence that it has led to the adoption of rubber flooring by many commercial houses, institutions, etc.

As the crisis in the plantation rubber industry developed, the Rubber Growers' Association realised that every effort should be made to increase the demand for the crude product, and consequently a special Propaganda Department was formed, with a view to developing existing propaganda activities and formulating a definite and comprehensive policy. A Propaganda Fund was established derived from voluntary contributions and a direct grant from the Association's fund. At the outset the work undertaken was mainly of an investigatory nature, with a view to obtaining from actual experience indications of the directions in which propaganda funds could be profitably utilised. Ultimately a scheme was prepared and submitted to the producing industry with an appeal for funds. A fund of nearly £40,000 was raised through the medium of a voluntary assessment on the part of the producing companies on the basis of 1s. per planted acre, and in addition direct grants were received from the Eastern Governments. Time will not permit of a detailed account of the activities of the Propaganda Department, and I will merely refer to certain

lines of propaganda activity which have been developed and which have proved of great value.

Actual publicity has been actively developed with a view to educating the general public as to the actual possibilities of rubber. For example, the domestic uses of rubber were brought to the notice of the British public by means of a booklet. It was recognised that the shareholder in producing companies had a real interest in the creation of an increased demand for rubber goods, and a special index was compiled. Copies of the booklet were sent to shareholders, and simultaneously a Press campaign was inaugurated, directed to the trade and to the general public. The result of this campaign was that 450,000 copies of the booklet were distributed and a considerable amount of publicity was obtained, which resulted in thousands of inquiries being received and transmitted to the manufacturing and distributing sections of the industry.

Another example of publicity is the scheme which was carried out in respect of latex paper. Circulars were distributed to the shareholders, and an immediate demand was created. In addition, paper manufacturers were put into direct touch with retail establishments and effective distribution was ensured.

As an example of the value of co-operative publicity, I would instance the scheme which was carried out last December. A circular was forwarded to 190,000 shareholders in Great Britain, advocating the purchase of rubber goods for Christmas presents. Manufacturers were invited to participate in the scheme by furnishing particulars of such products as might be suitable, and leaflets from twenty firms were forwarded with the circulars. The immediate result was a stimulation of the demand for rubber goods, and several retail establishments reported that their stocks were cleared out. The foregoing are instances of propaganda for rubber manufactured products necessitating the co-operation of other branches of the industry.

It must be borne in mind, however, that the main object of the Propaganda Department is to develop the consumption of the crude product. Consequently, particular attention has been paid to propaganda for crude rubber products, the most outstanding example of which is the crepe rubber sole. This sole was introduced at the International Exhibition of 1921, and the Propaganda Department immediately concentrated upon the development of this most promising application of rubber. It was essential that supply and demand should be stimulated simultaneously. Consequently, publicity was developed in respect of the boot and shoe trade, and at the same time, in order to endorse the qualities of the natural product, the crepe rubber sole was introduced to the leading exponents of tennis and golf. Sample pairs of shoes were distributed, and opinions were received. Folders were prepared and addressed to shareholders and to all sports' clubs.

It will be realised that the introduction of the crepe rubber sole was attended by unusual difficulty, as it was necessary to overcome the prejudices of the trade in favour of well-established types of soles, and yet, in the incredibly short space of eighteen months, the crepe rubber sole was firmly established. The success which

attended the introduction of the crepe rubber sole has been described as one of the greatest sensations of the shoe and leather industry. This success can be directly attributed to propaganda. It is estimated that the propaganda undertaken by the R.G.A. has been responsible for the consumption of over 2,000 tons of crepe sole rubber. As a result of the reflex effects of the propaganda in Great Britain, a demand was created on the Continent, in America, and the British Colonies which necessitated an extension of propaganda activities. Over 330,000 circulars, in twelve different languages, have been distributed on the Continent, with the result that thousands of inquiries have already been received. In January, 1924, arrangements were made for the Propaganda Secretary to visit the United States of America to investigate the possibilities of a propaganda campaign in that country and Canada for the crepe rubber sole. As a result of those inquiries, it is estimated that there will be a world-wide demand for at least 7,000 tons of crepe sole rubber next year, provided that the necessary propaganda is undertaken. Other publicity activities which may be instanced include the assembling of a travelling exhibition which consists of samples of rubber, specimens, models, etc., designed to demonstrate the story of the production of the crude product. This exhibit is available for use by retail establishments, etc., and is in very great demand. Exhibitions have been arranged on the Continent and in Great Britain, and retailers and others have testified as to the value of this type of publicity. On the educational side the Department is responsible for the preparation of lantern slides, lectures for schools and institutes, contributions to the Press, preparation of papers, etc.

Turning to the other main section of the Department's activities—namely, the development of new uses—reference has already been made to the results of the Prize Competition. As a result of the publicity obtained from the Competition and the subsequent publication of reports, suggestions are continually being received. These suggestions are examined by the Technical Consultant to the Department, and in those instances where there appears to be a prospect of development actual experiments are carried out. Numerous suggestions have already been dealt with, and practical developments have resulted in many instances. For example, rubber-cum-concrete blocks for tiling, rubber lining for barrels and tanks, incorporation of latex in paint, varnishes, etc.

It will be realised that the function of the Department is not financially to support the exploitation of new suggestions. The Department serves a very useful purpose as a clearing-house for new ideas, and every encouragement is given to inventors communicating with the Association. Grants of raw rubber, latex, etc., are continually being made, and there is ample evidence that the work of the Department is much appreciated by all sections of the public interested in the development of new uses for rubber.

The services of Patent Agents have been retained in addition to the technical consultant, and details of existing patents, etc., are supplied to inquirers. This proves helpful, as it obviates efforts in directions which have already been explored.

The future programme of the Department not only provides for the development of activities which I have enumerated, but

also for publicity for other applications of rubber generally. On the publicity side schemes are at present being considered for the introduction of latex greaseproof paper, propaganda for the use of rubber in the mining industry, applications of rubber in engineering and other industries.

I could give numerous other instances of the activities of the Propaganda Department, but time will not permit. I would refer, however, to the expansion of the Department. The outlook of the Rubber Growers' Association in respect of propaganda is not merely national, but is world-wide. Arrangements are being made so that branches on the Continent and in the Far East may be established, and the formation of local Propaganda Committees in Malaya, Ceylon, and South India is being organised. Co-operation is being maintained with the Propaganda Department recently formed by the International Association for Rubber Cultivation in the Netherlands Indies at The Hague.

I would point out, however, that the propaganda referred to already is being carried out by the producing section of the industry. The producer is the last to benefit from propaganda for rubber, and then only to a limited extent, according to the amount of crude rubber contained in the finished product. The producer is largely dependent for returns in respect of publicity expenditure upon the activities of the manufacturer and distributor of the finished goods. It would be unfair to expect the producing section to bear the whole burden of publicity for the rubber industry and its attendant expense.

It is gratifying to note that the greatest organisation of rubber manufacturers, the Rubber Association of America, is alive to the possibilities of publicity and is actually engaged on propaganda work.

The United States represents the largest field of rubber consumption, actual and potential, in the world. I submit that a co-operative campaign of generic publicity for rubber, if undertaken in America by the manufacturers' organisations and the producers' organisations could be of immediate benefit to the whole industry.

Co-operation, to my mind, is the keynote of the situation. I referred earlier in my paper to the difficulty of organising and administering international co-operative movements. As a practical suggestion, I would put forward the idea that every rubber organisation should in the first instance set up a special committee to examine the question of propaganda for rubber from the point of view of that particular organisation. Each organisation has its own peculiar knowledge of local conditions. I would therefore urge the necessity for a close investigation of the possibilities of propaganda by every rubber organisation, in order that actual definite and concrete schemes may be evolved.

It is essential that such schemes should be as detailed as possible. Definite data as to the types of product to be dealt with, nature of contemplated publicity, estimates of expense and financial appropriations, etc., should be embodied.

The schemes would be circulated to the various organisations concerned, and a free interchange of views and opinions obtained.

By this means opportunities would be afforded of developing co-ordinated action.

In discussing the possibilities of co-operative propaganda, one cannot lose sight of the fact that various organisations in the rubber industry represent interests which, in the natural course of things, must be diverse in certain aspects. The whole industry, however, has a common bond in the desire for an increased consumption of rubber and rubber products. That increased consumption can be obtained by co-operative propaganda efforts, and it appears to me that it would be far more profitable in the interests of us all if, rather than looking round for points of difference, we all concentrated on the one common platform upon which we all can meet—namely, the increased consumption of rubber and rubber products.

DISCUSSION.

The CHAIRMAN: We have listened to a very interesting paper. Unlike some papers it is not destructive, but is to a very large extent constructive. I would like to draw your attention very particularly to the suggestion which was made towards the close that we should focus our attention very, very particularly upon points not of dissimilarity, but on points on which we are agreed. The different sections of the rubber industry as a whole are agreed on the point that they want to increase the general consumption of rubber and rubber products, and it is on that platform that we can all, whether producers, manufacturers, or distributors, come to an agreement. Surely it must be possible so to arrange our organisations that we can combine in the direction of increasing the general consumption of rubber goods, by which all sections of the industry will benefit in turn. The figure of 2,000 tons of rubber being consumed in one new use, in boot soles, is a figure which, in view of statistics giving the figure of approximately 400,000 tons as the total consumption for the past year, may seem small, but if you were to visualise 2,000 tons you would find it quite a big amount of rubber.

Figure it out in this way. Those of you who know London must have been struck lately by the temporary absence of the 'buses, formerly so common in the streets. Consider what the consumption of rubber by that great fleet of 'buses must be in one year in London. The amount of raw rubber used is about 150 tons only in a year, I understand. Consequently, the amount put upon the soles of the boots of the public in England and the United States and on the Continent represents a consumption of more than twelve times as much rubber as is used by the whole of the fleet of motor 'buses in the great City of London. Those of you who cross the streets of London in danger of your lives with these great Juggernauts coming down on you will realise a little what this 2,000 tons must mean.

Mr. CYRIL BAXENDALE: Are you referring to crude rubber, Mr. Chairman?

The CHAIRMAN: Yes, crude rubber. As I am sure many of you will have illuminating remarks to make on this subject,

which has been so ably opened by Sir Stanley Bois, I now invite discussion.

Mr. Fordyce Jones: I would like to express my appreciation of this paper, because I cannot help thinking, with due deference to the papers still before us, that this is still the most important subject that can possibly be raised. After all, the Exhibition itself is propaganda, and all our interests are on those lines. I have often sat under the chairmanship of Sir Stanley Bois and have looked on him as my chief in propaganda, but never before have I heard his views for the future put before us. I think he defined propaganda as "education." I feel that "education" is a very dangerous word. We learned to dislike it in childhood, perhaps, and if we are going to use the word in propaganda we must only do it among ourselves. People hate to be coerced into learning things. The cinemas tried "education" as such, but they failed.

Sir Stanley Bois: May I substitute "fully informed"?

Mr. Fordyce Jones: You will note that I added, "only among ourselves." On crepe rubber soles I am one of the "antis," being interested in manufacturing. It is rather interesting to be told, as I have just been told by somebody, that the crepe rubber sole will outwear three good reputable manufactured rubber soles. If the Rubber Growers' Association want to sell an increased tonnage of rubber I think it will pay them to let three pairs containing 60 per cent. of rubber be worn out rather than one pair of crepe soles. It is important to remember that in pushing crepe rubber soles, which to my mind have a limited application, though a valuable one for sports use, you are alienating the manufacturer and his interests. If you are going on without him you may sell the patent puzzle sole, non-slipping, with no nails, and so on, but do not forget that the other man is the one who will use the most rubber. But I am very pleased with Sir Stanley Bois's paper, and am glad I was here to listen to it.

Mr. G. R. Crowther (Secretary, Propaganda Department, Rubber Growers' Association): I think the claim made for the crepe rubber sole is that it will outwear three pairs of leather soles. I shall be surprised to hear that any good grade manufactured rubber sole contains such a high percentage of crude rubber as 60 per cent. That statement by Mr. Fordyce Jones came as somewhat of a surprise, because, from actual analyses of various types of soles in America, the percentage was found to be such that even if four pairs of those soles were worn out to one pair of crepe soles the rubber producers would be at a loss by comparison.

Mr. Fordyce Jones: I must not use names, but I have given you the figures reported of a reputable and well-known firm of high-grade manufacturers. There is a very popular sole on the market now in England which contains even more.

The Chairman: Perhaps since the advent of the crepe sole the quality of these soles has very sensibly improved?

Sir Stanley Bois: I think that is the real explanation. The application of crepe rubber for soles is not confined to sports, but

is also intended for general footwear, and we are therefore not in any sense working against the manufacturer of vulcanised rubber soles, but, if anyone, against the leather man, and I believe from information that has come to us that leather people are realising that and are acting accordingly.

Mr. CYRIL BAXENDALE: Another point that I think does not appear to have caught on in this discussion is this. After all, one object of propaganda is, I take it, to teach people what is good for them. I must not use the word "education." But surely the people who buy three pairs of made-up, composition rubber soles will be less likely to keep on buying rubber soles of that sort than if they could buy but one pair of crepe soles and stick to it. If the crepe soles are three times longer lived you increase your *clientèle*, so to speak. The immediate selling of a few pairs of soles is not so important. What we want is to encourage a whole crowd of people to wear rubber. I understand that the Boers in the kopjes get their boots torn to pieces in a few weeks. I believe there is an immense field for crepe soles there; a compounded rubber sole would not be of much use to them. I asked Mr. Fordyce Jones to speak on this, as I thought it would be well to thrash it out thoroughly. It is a very important point.

The CHAIRMAN: I see the Secretary of the Dutch Department of Propaganda is here, and we should like a few words from him as to the aspect of propaganda for the Netherlands Indies.

Mr. J. G. FOL: We commenced our work with the crepe rubber sole. When we started there was only one manufacturer making crepe soled footwear, but as a result of our work we now have five. That proves very clearly that the crepe sole is a very good selling article in Holland. In addition, we have had several enquiries from our colonies, showing that a good demand for the crepe soled footwear is expected from Sumatra, and I hope we will very soon find enquirers coming to us from Java, too.

Then we have done some work in connection with rubber flooring. The position of rubber flooring in Holland was this. There has been on the market a good deal of very bad material. When I started my work I found that it was almost impossible to sell that article. I went to some of the most prominent architects, and they said rubber flooring was of little use: it was an article still in its infancy. So we tried to find out what was the reason for this opinion, which obviously was wrong, and we found out that there were two reasons. The architect was not qualified to judge the material, and he was buying what he could get at the lowest price. The material was bad, and that is one reason why rubber flooring was not a success. The second reason was that several of the firms selling rubber flooring did not understand how to handle the rubber or the solutions to cement the flooring down. Now we have asked for the co-operation of the Netherlands Government Rubber Institute, and we have pointed out to all the architects that before buying flooring it is advisable to send samples to the Government Laboratory to have them tested. As a result of that policy

there is much better quality rubber flooring on the market, and it is laid better than before. One manufacturer informed me that it was much easier to sell it in Holland than before, and that this change was due to the work of our Propaganda Department.

We have also carried out work in connection with latex paper. We made several experiments, but apparently people are not so much in favour of latex paper, as the original value of its properties disappears when the rubber is oxidised. We do not consider the use of latex is technically sound. Perhaps improvements can be made in the factory, and perhaps in time we will overcome the difficulties.

We have distributed a large quantity of latex to people interested, and some interesting new uses have been found. I cannot tell you more because patents have been applied for, but we hope to be able to say more about these interesting new uses for latex in a few months.

The CHAIRMAN: We thank Mr. Fol for his remarks. They are very interesting to us here, and they will be interesting to a wider circle when the account of these proceedings is published.

Sir STANLEY BOIS: I do not think I have anything to add to what was contained in my paper and in my reply to Mr. Fordyce Jones. I am very glad, however, of the opportunity of hearing about the valuable work that has been already so successfully commenced by the Dutch Propaganda Department. It is a very great pleasure to me to realise that that Department has been founded to some extent at the instance of London. I have had the pleasure of meeting Mr. Fol several times in London when he has been able to get a good deal of information from our Propaganda Department, which has no doubt assisted in the foundation of the Department in Holland and has enabled them to make the excellent start he has told us about. It is the desire of the Propaganda Department in London, and they will spare no pains to ensure that the closest contact shall be kept with the Dutch Propaganda Department and all other organisations working on similar lines, and the progress that has already been made is a happy augury of our being able to form such a world-wide organisation of associations, as I have indicated in the paper I have read to you this afternoon.

LABOUR FORCES ON RUBBER ESTATES.

By N. C. S. BOSANQUET.

The CHAIRMAN (Mr. P. J. Burgess): The next paper is one by Mr. Bosanquet on "Labour Forces on Rubber Estates," and as Mr. Bosanquet is not present I propose to read it:—

One of the first men I worked under in the Straits once gave me his idea of the definition of a good manager. "A good manager," he said, "is the man who does the best work cheapest." To qualify, therefore, as a good manager, a man must have a good labour force. He must, in fact, have the labour which is best fitted to do the various classes of work which apply to his estate, and it is interesting to notice how labour forces in the F.M.S. have altered from the time estates were first opened to the present time, now they are in bearing. A man who is to do good work, and do it cheaply, would find it difficult had he to employ a Malay for weeding, a Sakai for tapping, or a Tamil for felling; and twenty-five years ago the average estate in the F.M.S. was using Sakai and Malay for its felling, Javanese for its draining, and a few Chinese for clearing up after felling, and Tamils were gradually being introduced into the country to undertake the work of planting and bringing into bearing.

The 1921 census figures for British Malaya are very interesting in this connection. These figures show that Perak in 1911 employed 20 per cent. Malays, 26 per cent. Chinese, and 52 per cent. Indians. In 1921 the figures of this State show 6 per cent. Malays, 7.4 per cent. Chinese, and 85 per cent. Indians, while Selangor increases its Indian labour force over the same period from 73.4 per cent. to 87.6 per cent. Pahang is the only State which reduces its Tamil labour force over this period, falling to 30.4 per cent. in 1921 as compared with 32.1 per cent. in 1911. Negri Sembilan increases from 42.1 per cent. in 1911 to 53.9 per cent. in 1921. These figures are, I think, extremely interesting, showing as they do that where the opportunity is given of employing Tamils it is very freely and readily taken, and the remarks in the 1921 census seem to confirm my view that Tamils are probably the most desirable labour to secure for successful and cheap working on rubber estates as soon as the process of opening the land has been completed. "Many estates in Negri-Sembilan, particularly where in the past it has been difficult to obtain Tamil coolies, seized the opportunity and replaced their Chinese by Tamil labour dismissed from estates in Selangor." The opportunity referred to was the drastic reduction of expenses during the slump when labour forces were being reorganised.

I suppose it would be accepted as a fact that the first essential on an estate of any kind is that the manager should be in a posi-

tion to know fairly accurately how many coolies he is going to turn out every day, and this can only be the case where he has an established resident labour force. It may be argued that there are countries where the resident labour force is always extremely small—such, for instance, as Java—and yet that the results are entirely satisfactory. This brings up the very interesting point of clean weeding *v.* selected weeding, and I believe that the reason that selected weeding is so frequently advocated in the Dutch Indies is largely due to the fact that the bulk of the labour is drawn from the Kampoengs, presenting itself only when no work is available in the paddy fields, and absenting itself whenever there is a demand on its services for harvesting, planting, or cropping the paddy. Every planter knows that the only cheap system of clean weeding is a regular round, and a regular round is an impossibility with an irregular labour force. The necessity of regular attendance is accentuated when we come to tapping. Cheap tapping and good yields are dependent upon the same task being tapped always by the same cooly, and every tree being tapped always at its regular interval. I believe, therefore, that the cheapest labour force is the Tamil, in that he is, with the exception of the Chinese, the only force which can be secured as a really permanent free residential labour force on the estate. I eliminate the Chinese because, however efficient they may be, they are usually expensive.

There are many estates in the Dutch Indies which claim that they can work cheaper than the average estate in the F.M.S., and the attitude of the Dutch with regard to restriction was, I believe, encouraged by the feeling that, should a cut-throat policy be adopted, their estates would, for this reason, be able to maintain themselves over a longer period than estates in the Straits.

It must be remembered that a large number of the estates in Java are interplanted with coffee, and that in allocating the expenditure on these estates a fair proportion is charged against the coffee. If such estate figures are carefully gone into it will usually be seen that very little of the expenditure would be eliminated if the coffee were cut out, and that what is actually taking place is that the cost of producing the rubber is being cheapened at the expense of the coffee, and that were the coffee non-existent the estate would be showing its true cost of producing the rubber, and that this cost would be considerably in excess of the figure which is usually shown in the accounts on such estates.

In considering production cost prices I think the fact is very largely overlooked that cheap working is more dependent upon a regular outturn of labour, and upon work being kept up to date, than upon the question whether the cooly is paid 40 cts. or 37 cts. as his day's wage, and I am convinced that those estates in the Dutch Indies which are able to show really cheap and efficient working are those which are so fortunate as to be in a position to give regular employment to their Kampoeng labour with comparatively little competition from the paddy field.

When we come to the question of wages, there is not such a vast difference in amounts paid to the different kinds of labour as

is usually supposed. The following list may perhaps give an idea of wages paid over a fairly extensive field :—

Ceylon, an average of about	50 cts. =	0/ 8
Chinese, Temerloh District	40 cts. to $1 per day =	0/11 to 2/ 4
Javanese and Malays, Negri Sembilan	40 cts. ,, 45 cts. per day =	0/11 ,, 1/1½
Tamils.—Coast Districts, F.M.S. ...	27 cts. ,, 35 cts. ,, =	0/7½ ,, 0/10
,, Other Districts	30 cts. ,, 40 cts. ,, =	0/8½ ,, 0/11
,, Pahang...	47 cts. =	1/1
Javanese and Madoerese, E. Java ...	35 cts. to 55 guilder cts. =	0/7 to 0/11
Soendanese and Bantamese, W. Java	30 cts. ,, 60 ,, =	0/6 ,, 1/0
Sumatra, E. Coast	42 cts. ,, 47 cts. =	0/8½ ,, 0/9½

Now, in paying these wages there is certainly one stand-out point which should be borne in mind, and it is that in paying a Tamil 27 to 47 cts. per day you pay him to do any work for which you may consider him to be fitted. He may, for instance, prove to be an indifferent tapper but a capital factory cooly, and you change his work accordingly; but if your Javanese is a tapper, he is a tapper, and he leaves if he finds that he is expected to do some other work.

Again, in the event of some particular work being behindhand, the whole labour force of Tamils can be put on to it, and the position is immediately straightened out; but a manager in Java cannot do this. He must either get in extra coolies from outside, should they be available, or try and catch up as best he can by means of the labour at his disposal.

We all know that weather conditions frequently throw out a programme of work on an estate, and I have seen weeding in Java weeks in arrears and the manager praying for dry weather, when he hopes to catch up again.

This does not happen on estates with permanent resident labour, and, as a result, the heavy expenses which are always incurred by work getting out of hand are avoided, and cheaper work is possible.

English estates restricting in Java find one of their problems to be the loss of tappers who could have been well and conveniently employed at other work. I suggest that the Javanese and Madoerese coolies are not nearly so adaptable as Tamils, and if my contention that regular outturn and a regular routine of work is the first essential for working an estate is correct, then I am of opinion that the Java estates must work with a very severe handicap when compared with the conditions in Ceylon and the F.M.S.; and in looking at the actual wages paid to the cooly, due attention must be paid to the work he does in return for it and the range of departments over which his services can be used.

A regular outturn of coolies is obviously dependent upon the labour force keeping fit, and here again I think that the resident labour force has a great pull over the estate employing labour from the Kampoengs. Under the efficient medical arrangements which operate nowadays in all planting districts in the F.M.S. and Ceylon, an epidemic is spotted immediately, and as far as possible can be controlled, while an epidemic running through a Kampoeng

and brought on to the estate can do an immense amount of damage and is not so well under the control of the manager.

Death-rate figures among estate labour forces in the F.M.S. in 1922 show 17.71 per mille—a most encouraging figure when it is seen that the death-rate for all races amounted in the same year to 25.74, showing the successful care which is exercised in looking after estate coolies. Nederlands Indies coolies employed in Perak, Negri Sembilan, and Pahang in the same year had a death-rate of 26 per cent., while Java shows 20.2, 21.0, and 19.1 for West, Middle, and East Java respectively.

In comparing the labour in Ceylon, the F.M.S. and Dutch Indies, on rubber estates, we have in each country a certain amount of indigenous labour, though, with the exception of Java —and even there coolies are imported from Madoera—not enough to go round. A comparison of recruiting costs is interesting. Sumatra easily heads the list in expense in recruiting, and it can be taken that a cooly on an estate in the East Coast costs some F.135 to-day, and in the South Coast F.110 to F.120. Compared with this figure Madoerese are brought into Java for a purely nominal figure, while Tamils cost $10 landed in the Straits, without allowing for the rebate, which can be said to wipe out the whole cost of recruiting, and about Rs.25 to Rs.50 in Ceylon.

At first sight these figures would lead one to suppose that Sumatra was at a great disadvantage as compared with the other countries mentioned, but it is important that due consideration should be given to the services received from the cooly after he has been landed on the estate. Java we may write off as paying nothing for importing coolies, but it gets the least work out of them. Afternoon work among coolies in Java can be considered a very moderate affair.

The British Commercial Agent, in his report of June, 1923, sums up the attitude of the Javanese towards work as follows:—

> " The uneducated cooly is also affected by the present shortage of work; but, in the writer's opinion, this is not of such consequence, as the Javanese are never anxious to find regular employment, and when work is not easily obtained they return to their kampoengs, where they are able to exist on vegetables, rice, and dried fish, procured for a few cents a day derived from the sale of the surplus production of their homesteads, or in payment for a few hours' casual labour a week."

Sumatra, on the other hand, gets a full day's work; and I am inclined to think that, provided bolters do not upset calculations by leaving the Sumatra estates in undue proportion, that that country can show as good returns, in spite of recruiting costs, over a three-year contract as the Java free cooly, as a result of the better day's work, and consequently smaller number of coolies required on the estate.

It is some years now since I worked Tamil coolies, but I have never seen any labour anywhere to touch them for work. In days before estates came into bearing they would work all day at their task for a " name," and turn out for cash again in the evening

and work till dark, and they still do the best day's work of any labour we have in the rubber industry.

In comparing the qualities of labour the question of bolters is an important one. Java again does not come into the picture, as the bulk of the coolies are kampoeng supplied, and not imported residents. But the figure given by the Labour Department in its report in the F.M.S. for 1922 is a hideous one. No less than 36,992 bolters are reported that year, and in 1921 42,164. Seeing that the total number of Indian coolies employed in the F.M.S. in 1922 was in the region of 130,000, this is an appalling percentage; but when it is considered that the Indian coolies recruited in 1922 only numbered 30,492 over the whole of the F.M.S., Straits Settlements, and Unfederated States, the proportion of bolters is alarming. I have no figures showing the bolters in Sumatra East Coast, but in the Lampongs I am informed that it is not unusual, when the bolting epidemic is acute, for an estate to lose 50 per cent. of its recruited labour.

Pay-day has an unfortunate effect on the outturn at muster the following day, and Java comes off badly in this respect, as it is the custom to pay coolies at much shorter intervals than in our colonies or Sumatra. In fact, some coolies are paid daily in Java—others weekly, fortnightly, etc.—as against the usual practice of monthly pay elsewhere.

In Ceylon and the F.M.S., the system of giving head-money to Kanganies is, I think, a most excellent one; it is to the Kanganies' personal interest to get his labour out to work. This system is not practised in Java or Sumatra, and the Mandoers are paid high wages without the incentive of head-money to encourage them to produce their coolies on the muster ground.

In Ceylon and the F.M.S. a feature of every estate is the number of children working in the field, and working in gangs composed almost entirely of children. I believe that the efficiency of the Tamil cooly in Ceylon is largely due to the fact that he is trained up as a child to work on the estate, where he not only serves to reduce the check-roll average, but does the most useful work, and gradually becomes expert in all departments of the estate. I do not remember ever to have seen kampoeng labour in Java turn out a children's gang—in fact, I think I am right in saying that it is never done.

Now that the rubber industry has arrived at the point when only the efficiently managed estate can see profits in the future, and when in all probability, even with the help of restriction, only a very small margin of profit is going to be obtainable as a result of economical working, the time can surely not be far distant when it will be necessary for managers to draw up their estimates and work their estates on the lines that estates are worked and estimates drawn up on the tea estates in Ceylon.

But is it possible to work to the decimal with an unknown labour force? I feel that, given a resident labour force, such as has been built up with such marked success in the Straits, F.M.S., and Ceylon, with every opportunity of working to a definite programme, a manager can really do "the best work cheapest." But if it is to be a question of the survival of the fittest, I fancy

that any Java planter who is chiefly dependent on outside kampoeng labour will find it hard to compete, in view of his uncertain labour force, with his competitors over the way.

Dutchmen, many of them, have an idea that we do not know how to work native labour. I have heard several Dutchmen express astonishment on hearing that all planters speak Tamil to their Tamil coolies. It is time they realised that in the Malay States and Ceylon we have probably the finest and most expert labour, and the most efficiently managed of any employed in the rubber-growing industry.

Up to the present the policy of the survival of the fittest has never been tried, but should it ever be tried I firmly believe that the most economical work will be shown by the properties with fixed residential labour, wherever they may be situated, and that those estates which are dependent upon the whims and fancies of the kampoeng will find the path of real economy a very thorny one.

DISCUSSION.

The Chairman: This paper is not technical in the sense that it requires long specialised training to understand it, and I should like to have criticisms on the paper from practical planters present, who will say how Mr. Bosanquet's views coincide with or differ from their own.

Mr. Noel Bingley: It is an extremely interesting paper and full of information. I agree with Mr. Bosanquet in a great many points. I think the Ceylon planter probably does get a better day's work out of his Tamil force than any other planter does out of his labour in any of the neighbouring countries.

As an old Java planter I would, however, like to make one or two remarks on the contents of this paper. One is about that passage where the writer says that you cannot use your labour in Java for different kinds of work, and if you use tappers for weeding they leave in a body It was that remark in the précis which was first read that led me to ask for the paper to be read in full, because I thought the context would probably modify this statement a little. I can only say I knew no estates in Java where you could not use labour for the various works it was required for. We used to use our resident labour, which formed a large proportion of the labour on most estates, for all purposes; when pruners were not doing pruning we turned them on to weeding; when we wanted them to carry cinchona and tea to the station twelve miles away we sent them, and they would bring back rice and other goods on the return journey. It was quite a common thing to put your labour on late in the afternoon to do any kind of work that was behindhand, for cash payment.

Another point which is of great interest to me, because it has a bearing on the question of the cost of production in Java compared with other countries, is that relating to the calculation of rubber costs. Mr. Bosanquet's paper rather suggests that the *majority* of rubber estates in Java have coffee also, and that by allocating overhead expenditure between coffee and rubber the f.o.b. cost of the rubber is considerably reduced as compared with

F.M.S. and Ceylon estates, few, if any, of which have coffee. Of course, that does apply to estates with a lot of coffee, but of the several Java rubber companies I am a Director of, I think only two of them have coffee, and I should say the proportion in Java that have it still to any extent is small. Speaking in a general way, I think you can take it that the average cost of production shown by Java companies represents the fair cost of the rubber.

One other minor point is where Mr. Bosanquet refers to the minimum inconvenience and loss from coolies bolting in Java as compared with Sumatra and other countries where they are dependent on imported labour. But in many parts of Java also, when establishing and maintaining a resident labour force, you have to import your coolies, some from longer and some from shorter distances, but all from Java itself, which makes it far easier for them to bolt if they want to, than if they have to get back by ship to their own country, as in the case of Java contract coolies in Sumatra, Malaya, etc.

In conclusion, I would like to say I think this is a most excellent paper, and I only want to draw attention to these one or two points, which, if Mr. Bosanquet had been here, I should have liked to discuss further with him.

Mr. Victor Ris: I want to say a few words about bolting in Sumatra. There has been bolting of a big number at times, but never up to 50 per cent. On the East Coast and on the West Coast of Sumatra and Atjeh it amounts in the year to, at the outside, 5 or 10 per cent.: 10 per cent. is considered a very high figure, and reflects very badly on the manager of an estate. About using labour for different purposes, for weeding, tapping, and other kinds of work, I agree with Mr. Bingley. You can do it on the East Coast of Sumatra, and I think in other parts; you can use the labour for any kind of work you like. They are trained to do any work they are put to. That is my experience. I refer to only one point that has not been raised by Mr. Bingley. Something was said about child labour on estates, of which a great deal is said to be done in Ceylon and the Malay States. The mentality of the English in the Colonies and the Tamil seems to me quite different from that of the Javanese. The Javanese would never agree to children working regularly on estates, and we East Coast Sumatra planters in this country are of the same opinion. Most of us would have stopped it even if the parents had agreed to send their children. We do not believe in employing children.

Mr. Baxendale: I join with Mr. Bingley in expressing appreciation of the very interesting paper sent over by Mr. Bosanquet, and in his regret at his not being here to stand the criticism. Mr. Bosanquet's position is, I think, almost unique in that he has had several years of working experience in Ceylon, the Malay States, and the Netherlands Indies.

The Chairman: I would like to ask Mr. Ris if he can give any explanation of the attitude of the Javanese in regard to child

labour. Is it because it is thought to be against the idea of free, happy childhood, or for other reasons?

Mr. Ris: The Javanese does not wish his children to go to earn money. He wishes them to be free. Also, the children are very free in their relations with their parents, and the children themselves would not go to regular labour. If the parents wished them to go they would not. I have very little experience of the mentality of the Tamils.

The Chairman: It is an interesting point in psychology.

Mr. Ris: As to the death-rate of coolies, I may say that it is between 7 and 8 per thousand in the East Coast of Sumatra. Twelve would be regarded as a very high rate.

TAPPING SYSTEMS IN SUMATRA (EAST COAST).

RESULTS OF A QUESTIONNAIRE HELD IN JUNE, 1923.

By J. G. J. A. MAAS.

The CHAIRMAN (Mr. P. J. Burgess): I have great pleasure in introducing to you Mr. Maas, who is going to read to you a paper on "Tapping Systems in Sumatra," and I am sure you, as well as myself, are looking forward to what he has to say.

Mr. MAAS: A few years ago daily tapping, with two cuts on one-quarter or one cut on one-third of the circumference, was generally applied, in the F.M.S. as well as in Java and Sumatra.

For several reasons—viz., brown bast disease, rubber restriction, decrease in the price of rubber—there was a tendency to lighter tapping systems and the employment of less tappers.

In the F.M.S., and to a less extent also in Java, tapping developed in the direction of alternate-day tapping. On the east coast of Sumatra daily tapping remained—for various reasons. First of all, brown bast disease had never occurred so seriously as had been the case in Java and the F.M.S. In the second place, in Sumatra since 1919 tapping has been done with one cut on one-third of the circumference; in the F.M.S. and especially in Java the two-cuts system on one-quarter remained longer in use, which promoted the brown bast disease.

These differences in the former tapping systems are to a great extent responsible for the fact that experiments with alternate-day tapping in Sumatra have not given such favourable results as were recorded in practice in the F.M.S. and Java. In these last countries the introduction of alternate-day tapping no doubt was responsible to a considerable extent for fewer trees being put out of tapping owing to disease. Besides, when comparing daily and alternate-day tapping the results are more distinctly in favour of alternate-day tapping when experimenting with two cuts than with one cut.

Circular No. 8 of October, 1921, from the General Experimental Station of the A.V.R.O.S., reported that, though alternate-day tapping was being more and more adopted in the Netherland East Indies, the results of the experiments on the East Coast of Sumatra, which had been in operation for one year, were not so favourable, and that, in order to obtain the same yield and to prevent an increase in the cost price, the tapping cut had to be lengthened.

For this reason, in the beginning of 1921 experiments were started with periodical tapping—a system that was already experimented with especially in Ceylon and Cochin China—viz., every other month, etc. In the A.V.R.O.S. Circular No. 14 the conclusions concerning alternate-day tapping outlined in Circular No. 8 were confirmed, and in Circular No. 15, of April, 1922, the results of experiments with periodical tapping, the system of the future, were published.

In September, 1922, the Director of the Experimental Station of the A.V.R.O.S., Dr. Rutgers, delivered a series of lectures, in the nature of propaganda, in favour of periodical tapping, which until then had only been in use on a few estates.

In June, 1923, the results of this propaganda were investigated. The investigation showed that though in the middle of 1922 daily tapping was in general use, in June, 1923, that is, a year later, periodical tapping was more frequently adopted. Alternate-day tapping, which, according to Schrieke's report,* was adopted almost exclusively in the F.M.S., was only exceptionally applied in Sumatra.

As a result of the Questionnaire, replies were received from 111 estates, representing 185,747 acres in tap.

On 68 estates some kind of periodical tapping was exclusively adopted; on 16 other estates periodical tapping was done only to a certain extent. Daily tapping was done on 39 estates, of which 24 tapped daily exclusively, no other system being used; the remaining 15 tapped daily, and used at the same time another system on part of the estate. Four of these last estates decided already to start periodical tapping. On five estates the alternate-day tapping was applied. Two of these were also tapping periodically to some extent, so that only three out of 111 estates applied the alternate-day system exclusively.

Periodical tapping was applied on 131,245 acres (71 per cent. of the total area).

Daily tapping was applied on 48,088 acres (26 per cent. of the total area).

Alternate-day tapping was applied on 6,414 acres (3 per cent. of the total area).

Schrieke arrived at the following figures for the F.M.S. From 77 estates 68 applied alternate-day tapping, 9 daily tapping and none periodical tapping, or in acres; 84,070 acres (90 per cent.) alternate-day tapping, and 8,900 acres (10 per cent.) daily tapping. At the present day periodical tapping is used in the F.M.S. too, though I do not know by how many estates.

Entering into details we have to pay attention to the *length* of the tapping cut.

From the 39 estates in Sumatra, above mentioned, that used daily tapping, 31 gave information on this subject; 26 applied one cut on one-third—the system formerly generally adopted on the East Coast of Sumatra. On 3 estates tapping was done with one cut on one-quarter, on one estate with one cut on one-half,

* Archief v.d. Rubber Cultuur, 1922.

and only one estate kept to the now almost discarded system of two cuts on one-quarter daily.

On 5 estates alternate-day tapping on one-half was applied. On part of one of these estates tapping on one-third was done.

Schrieke found that shorter cuts were in vogue in the F.M.S. From 7 estates, which tapped daily, 6 had the cuts made on one-quarter and one on one-half. From 68 estates, which tapped every second day, 23 tapped on one-half, two on one-third, and 37 on one-quarter, four others tapped partially on one-half and partially on one-third, while on two others tapping was done on one-half and one-quarter. So most estates used alternate-day tapping with a very short cut on the circumference.

With periodic tapping in Sumatra daily tapping was always applied in the tapping periods, which alternated with periods of complete rest. Tapping and resting periods were different, as is shown in the following tables :—

I.—75% of tapping days and only 25% of resting days.

System.	3 months tapping, 1 month rest.
Number of estates	2
Acreage	1494

II.—67% of tapping days and 33% of resting days.

System.	5 months tapping, 2½ months rest	4 months tapping, 2 months rest.	2 months tapping, 1 month rest.	1 month tapping, ½ month rest.
Number of Estates...	1	6	8	2
Acreage	780	11567	11406	5465

III.—50% of tapping days and 50% of resting days.

System.	4 months tapping, 4 months rest.	3 months tapping, 3 months rest.	2½ months tapping, 2½ months rest.	1½ months tapping, 1½ months rest.	1 month tapping, 1 month rest.
Number of Estates...	1	1	2	5	57
Acreages	2355	50	1740	6384	73854

IV.—33% of tapping days and 67% of resting days.

System.	1½ months tapping, 3 months rest.	1 month tapping, 2 months rest.
Number	1	1
Acreage	40	1490

By far the greatest use is made of periodical tapping every second month. The resting period is seldom shorter than one half month and longer than two months. The tapping period is never shorter than one month—the results of experiments in this direction, tapping only half-a-month, were not encouraging—and as a rule not longer than two months.

Generally the length of the tapping cut was not communicated.

The replies which deal with this question gave the following information :—

Length of tapping cut when tapping periodically.

	Tapping Systems.										
	67 % of tapping days.			50 % of tapping days.					33 % of tapping days.		
Length of Cut	½	⅓	¼	½	½ & ⅓	⅓	⅓ & ¼	¼	½	⅓	¼
Number of Estates	3	7	1	32	3	14	1	—	2	—	—
Acreage	5755	13155	1470	52296	2061	12153	1314	—	1530	—	—

With 50 per cent. of tapping days—*e.g.*, tapping every alternate month—the cut is usually made on one-half, though on one-third is not an exception.

When tapping is done over 67 per cent. of the days the cut is usually one-third; on two estates where tapping was done on 33 per cent. of the days the cut was on one-half.

From the tables above it appears that the development of tapping systems in the direction of a more conservative consumption of the bark has not come to a standstill. The development is going into two directions:

(*a*) Further decrease of the number of tapping days (from 50 per cent. to only 33 per cent. of tapping days and 67 per cent. of resting days).

(*b*) Shortening of the tapping cut (from one-half to one-third), applying 67 per cent. or 50 per cent. tapping days.

Experiments in both directions have been started already by the A.V.R.O.S. Experimental Station.

Advantages of the present system.

So you see that in Sumatra, as results of experiments which will be published this year, we came to the alternate-day system, contrary to the systems used in Java. The special advantage of this tapping system is that it enables us:

1. To obtain the same yield at lower costs than with daily tapping.

2. To obtain a longer period for bark renewal without loss of yield.

3. To increase this period for bark renewal at every cycle of tapping without being obliged to tap at too great a height from the ground.

As far as is known no other system offers the same advantages to the same degree, at least not on the East Coast of Sumatra, and it seems probable that periodical tapping will be the system of the future, as has been already mentioned in our Circulars.

Mr. Maas produced for inspection a number of photographic plates illustrating tapping systems used in the past and the present.

DISCUSSION.

The CHAIRMAN: I am sure I shall be voicing the feeling of all of you in thanking Mr. Maas for the paper he has read to us. It

shows that he has devoted a great deal of time and given a great deal of attention to this question of tapping, and has made himself a master in the methods which are practised in Sumatra. One question I should like to ask him is whether he can give us some absolute figures of the yields which have been obtained by these different systems. He has shown that the severity of the system has been gradually decreased since 1914 and 1915, notably in more recent years, till they have now come down to alternate tapping with a month's rest, and according to Mr. Maas they are obtaining about the same yields as they got with more drastic tapping. He has not given the figures per acre.

Mr. Maas: I have the figures here and the results will be published in a few months. In all the experiments it is possible to obtain the same yields with some system of periodic tapping as with daily tapping on one-third; having no greater but even less bark consumption, and using less labour.

The Chairman: That is an important point, but, as he indicates, we have not yet come to the end of the experiments, and we have to see how much further we can go in less and less severe systems of tapping. I hope we shall not come to the condition the poor horse suffered from when for experiment they reduced his daily allowance of hay till it came down to one straw, when unfortunately the horse died. We want, if we can, to obtain information as to what is the maximum amount of crop we can obtain without damage to the trees. I think the point is of such fundamental importance to the industry that it should be worked out. I am sure other members of the Congress would like to ask Mr. Maas some questions on this important point, and I should welcome any discussion of the figures and facts he has presented.

Mr. Maas: It seems it is not advisable to have an interval between successive tappings greater than two or three days, and resting and tapping periods longer than four months seem to give less satisfactory results than periods of one or two months. On the other hand, it is not recommended to have too short periods, for half-month's tapping and half-month's rest are not good. There are rather good results with tapping every third day, so that seems to be the limit regarding the interval between successive tappings.

Sir Wyndham Dunstan: I think we ought to congratulate ourselves on having Mr. Maas here this morning, and I cannot help thinking that this paper is the sort that we British should welcome, as putting before us the important results our colleagues in other countries are obtaining.

This is a very interesting question from the scientific point of view. It comes to ascertaining the balance of advantage between the stimulus of latex flow due to the tapping and the exhaustion due to frequent removal of the latex. The results given this morning are likely to enable us to discover exactly how far tapping can go without affecting yield and quality, and consequently the well-being of the industry—which obviously is

the horse in the story the Chairman referred to. The practical point is to prove what the industry is to gain from adopting such restriction in tapping. It is important that we should bear in mind that trees on the East Coast of Sumatra may possibly not give the same results as trees in other countries. I feel sure that climatic influences will have to be taken into account and discussed, and therefore it is very desirable that this kind of enquiry should be made in other places in a systematic way. I should like to see a corresponding set of results obtained on the same lines both in Ceylon and Malaya.

We appreciate very much Mr. Maas's presence and the very valuable paper he has given us.

Mr. Cyril Baxendale: I associate myself with what Sir Wyndham Dunstan has said as to the paper. There is a point on which Mr. Maas or yourself, Mr. Chairman, can give us some information. It has caused a little anxiety in the Malay States. It is as regards the quality of the rubber which is produced by periodical tapping. I have read recently—and I cannot quote my authority, either the writer or the magazine in which I read it, but I rather think it was in the Rubber Growers' Association's Bulletin—that the effect of periodical tapping was that you got a larger proportion of discoloured rubber. All of us who have had experience of tapping—I have done a good deal with my own hands in past years—have found that when we open our tree again we get a good deal of lumpy rubber that coagulates rapidly. It was not till I read that article that I found that the rubber was inferior in any way to the other.

As I understand the periodical methods, the practice followed in the Malay States, called "ABC tapping," is for two months you rest one-third of the area. Then you tap two months and drop another third of your area.

Mr. Maas: You mean one month tapping and two months' rest? I think it is advisable to compare this system with the two months' alternate daily tapping and one month rest.

Mr. Baxendale: Perhaps you can answer the question as to whether there has been any opinion expressed as to the damage that is done to the quality of the rubber itself? We have to be very careful, of course, not to create any feeling of apprehension among our buyers.

Mr. Maas: First I will refer to what Sir Wyndham Dunstan said. I cannot say it is advisable to adopt without further investigations the same methods in Malaya and Ceylon as in Sumatra, because the climate surely has its effects. Already on the East Coast of Sumatra we found that on one estate alternate monthly tapping may be better than, for instance, two months' tapping and two months' rest. But on other estates it was found advisable to have longer tapping periods. It is clear that climate makes some difference. Obviously the result will not be quite the same in Ceylon as in Sumatra. In answer to Mr. Baxendale, samples of the rubber produced in several tapping experiments have been investigated by Dr. de Vries, and I expect

that the results of his investigations will be published in a few months. He has expressed already the preliminary opinion that resting periods longer than three or four months have a bad influence on the quality, on the uniformity, of the rubber, but resting for two months has no bad influence on this uniformity. From this point of view there is no objection against a resting period of one or two months. As far as our experiments show—we have had only a very few—as to the quantity of first latex rubber, the percentage of first latex is higher with alternate tapping than it was before with daily. The percentage of scrap is less. I think there is no objection against periodical tapping when we do not use resting periods longer than three or four months.

Mr. BAXENDALE : If that is the case, if the quality of the rubber is actually deteriorated by long periods of rest, then it would seem—I do not know whether the argument holds good—that if we were to leave our trees alone for, say, ten years without tapping the quality of our rubber would be depreciated.

Mr. MAAS : Not permanently.

Mr. FOL : There is only a small change in the uniformity of the rubber as far as the rate of cure is concerned. This change is of only a temporary character, and after a couple of weeks the rubber becomes normal again.

Mr. BAXENDALE : Has not an English authority expressed an opinion on this, Mr. Chairman?

The CHAIRMAN : I think the article Mr. Baxendale has referred to was the work of Dr. Stevens. It appeared in the Rubber Growers' Association's Bulletin, and was on the question of the variation in the vulcanising capacity of rubber according to the period of tapping.

Mr. BAXENDALE : Does his opinion confirm the opinion of the gentleman who has just spoken, that it is only very temporary?

Sir WYNDHAM DUNSTAN : The point really is this, as I understand it. If you allow this long period of resting apparently certain changes of metabolism take place in the tree, and constituents are developed in the latex, and these interfere with vulcanisation results. It may not be the quality of the rubber, as rubber, that is concerned, but a difference in the vulcanisation results brought about by some other constituents in the latex formed during the resting period. When the tree is tapped again these tend to disappear, to some extent at all events, and then you get normal vulcanisation results.

Mr. MAAS : Only in its uniformity, and with resting periods of not longer than three months, say, the difference in uniformity is very small. From this point of view there is no objection to periodical tapping. It would be good to await the full results of Dr. de Vries's experiments.

The CHAIRMAN : Does this variation in respect of uniformity involve a change in the appearance of the rubber and the character

of it? I have an impression that there is a considerable alteration in the superficial appearance of the rubber.

Mr. Maas : Usually the rubber from newly tapped trees is a little bit more yellow, but I would point out also that when you are tapping periodically you do not rest the whole area at the same time, and the rubber from the trees that are newly re-opened is always mixed with the other rubber from the estate, so it would not make a noticeable difference in the rubber from the whole estate.

The Chairman : The difference is more academic than actual, perhaps. I think we will bring our discussion to a close with a very hearty vote of thanks to Mr. Maas for his paper. This afternoon Mr. Noel Bingley will read a paper on " Cover Crops and Clean Weeding."

Sir Wyndham Dunstan : Perhaps Mr. Maas could make this meeting known to his Dutch friends. They would be very welcome then. The paper is on English experience with cover crops.

COVER CROPS AND CLEAN WEEDING.

By NOËL BINGLEY.

Sir STANLEY BOIS, who presided, said: I do not think Mr. Noël Bingley requires any introduction from me to those who are conversant with the Dutch Indies, so without further delay I will call on him to read his paper upon "Cover Crops and Clean Weeding."

Mr. NOËL BINGLEY: When I was asked to contribute a Paper on this subject, which I regard as one of the most important affecting the permanent welfare of our tea and rubber estates, but with regard to which there are two such distinct schools of thought, holding diametrically opposite opinions, my impulse was to decline the honour, and for the following reasons:—

Quite apart from the fact that I know there are so many far more qualified to deal with this subject, and in closer touch with local conditions, which have an important bearing on these matters, than I can now claim to be, I felt that this particular subject would perhaps be better entrusted to the hands of someone who held less definite views on this subject than I do.

For, personally, I have been from my earliest planting days, which date further back than I care to remember, a consistent believer in "selected weeding" as opposed to "clean weeding," and of later years a firm supporter of the cultivation of cover crops, which are the present-day substitute for the soft and harmless weeds that did service with many of us in the old days towards preservation of soil.

Also I am very conscious of the fact that most Ceylon planters —who, as a body, I recognise are second to none in the success they have made of their tea and rubber industry, and whose opinion must always carry great weight with any student of tropical agriculture—are still firm believers in clean weeding, and I might almost say intolerant of any other system.

To obviate my Paper being of a one-sided nature, and that the arguments in favour of both systems might be placed fairly before you, I asked two or three of my Ceylon friends whom I knew to be fervent supporters of clean weeding to supply me with arguments in support of that system. These seem to be mainly two in number:—

> *Firstly,* the economical one that no cheaper system has yet been found; and *secondly,* the unqualified success that the Ceylon planters have made of their tea and rubber industry, the force of which we must all recognise.

With regard to the first claim, I much doubt if the last word has been said, for I have seen quoted reliable figures of annual upkeep cost of areas under well-established cover crops in Java

that will take a lot of beating. At a planters' meeting held in Java last year as low a figure as F.2 per bouw, or under 2/- per acre, was quoted as the annual weeding cost of the rubber gardens on a well-known estate under well-established *Vigna Oligosperma,* whilst F.5 per bouw, or less than 5/- per acre, was the figure which the meeting considered to be a normal annual cost under similar conditions. As this figure was lately quoted by a colleague now on a visit to Java as the annual weeding cost of 1,000 acres of tea under *Vigna,* I tnink we may accept it as a safe one for comparison with other systems. I venture to suggest that few clean weeded estates can show a cheaper figure when one takes into account that a well-established ground cover obviates much expenditure on draining and other soil-preserving works.

One whom I knew to be an ardent supporter of clean weeding as the only sound system has been good enough to put his views on paper, and I do not think I can do better than take this useful memorandum for my text, giving extracts from it where they refer to any particular feature of this subject we are discussing. Here is one of them :—

> " I have always held that, especially when consideration is given to the poor soil in most parts of Ceylon, planters in that island have made a success of their cultivation. It is the experience of a large and competent body of men over a long period of time which convinces me that the system almost universally adopted in that island must have some great benefit. Clean weeding has first and foremost the great advantage of helping to maintain a satisfied labour force. Many planters have found that a weedy estate is difficult to control, the tasks given to the coolies sometimes lead to friction, and the appearance of the property is discouraging to all. Furthermore, it must be remembered that on estates where clean weeding is in vogue the costs of the work can be closely calculated and contracts given out to the kanganies whereby they are able generally to make a small profit on a weeding contract. Such an arrangement would hardly be possible for years in succession on an estate which was not kept clean."

If the writer had in mind a comparison between clean weeding and " selected weeding," rather than an estate under cover crops, as I think he must have had from his reference to " the difficulty of controlling a *weedy* estate," there is undoubtedly a great deal to be said for the first-named system from the standpoint of cheap weeding and contentment of the labour force and easiness of control.

All the same, I venture to think that, from the purely agricultural point of soil retention and maintenance of the surface soil in a cool, unbaked condition, which is so beneficial to all plant life and to the preservation of those micro-organisms which are so essential to the " live " characteristics of the soil, there is very little to be said for clean weeding.

By " selected weeding " I mean the regular eradication with the foot or hand-fork of all harmful weeds, and especially of all

Lallang and other *grasses* which, as I know by experience, will always appear sporadically, but can be reduced to a negligible minimum by systematic and regular removal as soon as they show themselves, at the same time leaving the harmless weeds to be dug into the soil periodically. I allow this system requires from the estate staff considerably more personal control and attention and careful training of the coolies in the early stages than the more routine work of clean weeding. It also entails their intimate acquaintance with the character and effects upon the soil and cultivated plant of the weeds of the country; but this is after all only a matter of ordinary intelligence and observation, whilst most natives seem to know by instinct which are the harmful and which the harmless or beneficial weeds indigenous to their country. I venture to think that every Java planter who has studied this subject is familiar with the appearance and characteristics of "Babadottan," "Djoekoet Minggoe," the various varieties of "Sintrongs," "Trefolia" and "Desmodium" indigenous to Java, and, last but not least, the "wild balsam," which grew in profusion on the Government and the best cinchona estates in Java. Nor do the estimating or control of the costs of this system offer the insuperable difficulties suggested by the writer I have quoted from, if it is once in hand and thoroughly understood by staff and coolies alike.

Mention of the "wild balsam," or "Patja-tjere" as it is called by the Soendanese of West Java, recalls to my mind many an enjoyable expedition in my early cinchona-planting days, in the company of the late Dr. van Leersum, for many years Director of the Government Cinchona Gardens in Java, when he made his periodical rounds of inspection. And the chief impression that these visits left in my mind is that of riding through miles of magnificent, well-developed cinchona trees, standing—partly on terraces and partly not—midst a deep, luxuriant growth of "patja-tjere" and similar weeds.

To my mind our Java cinchona cultivation is an object lesson in itself of the virtues of "selected weeding," for, without wishing to minimise the excellence of the soil on most of these estates, I think there can be little doubt that the long life the cinchona enjoys in those districts is to a large extent due to the system described, and to the complete absence, as far as I remember, of clean weeding in any form. For, however superior the original soil of these old cinchona estates was, it is impossible to conceive that, in the course of the forty to fifty years that some of them have been in existence, most of it would not have disappeared by now under any form of clean weeding, and the cinchona, if it survived at all, be dependent for its existence upon artificial manuring.

Another argument of the advocates of clean weeding is that a large proportion of the fertilising properties of the soil is absorbed by any alien vegetation, to the detriment of the cultivated plant, and especially so in the case of manured land. In

this connection may I again quote from my Ceylon friend already referred to, who writes as follows :—

> " Clean weeding means that the only roots in possession of the soil are those of the plant under cultivation, and therefore all the available nutrition in the soil has a chance of going into the plant under cultivation, and not into extraneous plants being cultivated, or allowed to grow wild, on the same area. It is for this reason, I believe, that trees planted on clean land which is kept clean weeded show a better growth than those reared under unclean conditions."

I have always understood that the bulk of the plant food so absorbed is eventually returned to the soil, which is certainly the view of the Dutch Agricultural Scientists to whom I will refer later. A similar opinion was expressed in a paper on our present subject contributed a short time back to the Agricultural Bulletin of the Federated Malay States by Mr. F. G. Spring, Agriculturist on the staff of the Department of Agriculture, F.M.S., who wrote as follows :—

> " Some planters argue that cover plants impoverish the land, but this is a mistaken idea. When the residue of plants, other than those belonging to the order *leguminosæ*, is incorporated in the soil, the material which has been taken from the land is returned to it; but with leguminous crops this material is not only returned, but it is possible to increase the actual amount of nitrogen in the upper layers of the soil. An additional advantage in growing a cover crop is that the plant takes up part of the elements as they become available in the soil which might otherwise be lost in drainage."

But, whether you entirely agree or not with these views, can one doubt that the chronic erosion of soil that is the natural result of years of clean weeding is not a greater and more permanent danger to the cultivated plant than the partial loss of plant food suggested.

True, it is frequently stated that loss of soil where clean weeding is combined with a draining system, such as is found on most Ceylon estates, is negligible, and this is also intimated by the writer I have already quoted, who writes as follows :—

> " Clean weeding, it is said, results in a loss of soil. This is quite true where the areas which are kept clean are allowed to become hard and baked. But weeding cannot be considered by itself. It is common knowledge that on estates where this system has been in vogue for years, but accompanied by mechanical cultivation of the soil, maintenance of effective draining, and by digging silt-pits, a serious check is put on the loss of soil."
>
> " I well remember putting in a large dose of Manure on an Estate in the Watawella district of Ceylon. Immediately the manure was applied (which, by the way, was of a very soluble nature), the land was forked to a depth of 9 inches. The district was a very wet one, and on the day of applying the manure there was a fall within one hour of over 6 inches of

rain. I purposely visited the plots which had been manured and forked that day, and found that the water in the drains was not muddy, it was perfectly clear as though it had come out of a filter bed. That instance proved to me that clean weeding on a hilly estate, accompanied by deep forking, even in a wet district, was sound, and all wash was practically stopped."

If you will permit me, I would like to quote some extracts from an article by the Director of Agriculture in Ceylon, published last September in " The Tropical Agriculturist," which certainly does not bear out these claims on behalf of clean weeding, and which seem to me to have an important bearing upon the question with which we are to-day concerned. Here is one of them :—

" The most serious problem that agriculturists in Ceylon have to face is soil erosion. It is the greatest danger that threatens Ceylon agriculture and the permanency of at least two of its staple industries. It must be looked at from the broadest possible point of view, and steps must be devised to prevent that loss which is annually occurring. Otherwise disaster is bound to occur."

Again, in a late joint report by the Ceylon Surveyor and the Director of Irrigation, frequent reference is made to the serious damage that is being caused by what they describe as " the excessive denudation of the upland soil taking place on tea and rubber estates in Ceylon," which, it is suggested, must end (I again quote their own words) " in eventual complete removal of the upland soil from estates," and which is entirely attributed to " the operation known as clean weeding." The authors of the report urge in no half-hearted terms the discontinuance of this system and the " encouragement in its place of the growing of plants of low habit on estates."

It is interesting to note that this question was also under the serious consideration of the Indian Board of Agriculture as far back as 1916, when a special committee was formed to investigate and advise upon the question of soil denudation and surface drainage. Their report expresses the opinion that the mischief done by insufficient attention to loss of soil through existing methods is " irreparable," and such as can " never be remedied by any system of manuring."

There are several references to a report by Dr. Hope, B.Sc., Chief Scientific Officer to the Indian Tea Association, upon a visit he paid to Java and the methods he found in use there for protection of soil, which include selective weeding, the planting of cover crops, and free use of silt-pits, the adoption of which in Assam and elsewhere were strongly recommended by this committee. In connection with this report, and as affording evidence that the sentiment in favour of cover crops in lieu of clean weeding is gaining ground in other countries, in spite of all arguments advanced by the " die-hard " champions of clean weeding, it is interesting to note that the Deputy-Director of Agriculture for the Planting District, Madras, in a paper read before the Sixth Science Congress referring to this same report by Dr. Hope

of his visit to Java, made the following remark :—" In Southern India, at any rate, I am happy to say the fetish of clean weeding is rapidly becoming obsolete."

Let me now give you the opinions of a couple of our leading agricultural scientists in Netherlands India, Dr. C. Bernard, Director of the Java Tea Experimental Station, and Dr. Ultee, Director of the Malang Experimental Station, chiefly concerned with rubber and coffee, both of whom have constantly during the last few years expressed their opinions in definite and convincing terms against clean weeding.

In a paper on " Green Manures," read before the Soekaboemi Planters' Association last April, Dr. Bernard put forward one of the most convincing cases in favour of ground covers and against clean weeding that I have so far read. Referring to the progress made by the Government Experimental Institutions in investigating the individual properties of the different *leguminosæ*, he made the following statement :—

> " It is strange that although this subject is one of such urgency, and most people are convinced of the favourable influence of *leguminosæ*, the use of them is still far from universal, and the very harmful custom of ' clean weeding ' is still practised on so many estates."

Referring to the argument that clean weeding is the cheapest form of upkeep, which he allows in the case of gardens once thoroughly clean, on the ground that " selected weeding or the establishment of *leguminosæ* in the beginning require much higher upkeep costs," he said :—

> " I say ' in the beginning,' because I am convinced that there is nothing more expensive than clean weeding, and especially because of the very damaging effects which this method has upon the soil. . ."

After explaining that the effects of *leguminosæ* are as beneficial to the biological properties of the soil as they are to its chemical improvement, Dr. Bernard makes the following interesting statement :—

> " It is an acknowledged fact that the roots of leguminous plants have the same effect upon the soil as deep tilling. A cover of *Vigna* or *Mimosa Invisa* produces in a few months on the surface of the ground a beautiful layer of fresh humus, rich in nitrogen, under which the soil has become very porous."
>
> " Soil defective in moulds, bacteria, etc., is unsuitable for cultivations. These micro-organisms are indispensable to convert organic matter into soluble salts. In this respect clean weeding is very harmful. In young, clean-weeded gardens the soil is sometimes scorched to quite a considerable depth, killing all micro-organisms. Green manure will restore such soil to utility in a few months' time."

His lecture concluded with these words :—

> " The use of *leguminosæ* as green manures between the plants of the main cultivation is in all cases and under all

circumstances to be recommended—on good soils in order to preserve the favourable properties (chemical and mechanical), and on bad soils to improve their bad properties."

Summarised, his paper shows that soil covers of various kinds have simply been the salvation of many rubber estates where serious loss of soil had already taken place, and that Tephrosia, Crotalaria, Vigna, Centrosema, Mimosa, and other cover crops have all in their special way restored "life" to soils ruined by clean weeding.

In the course of an equally interesting paper on "Green Manures," read by Dr. Ultee at the Malang Planters' Association last August, he said:—

> "In 1920 I advised clean weeding on flat estates, not because I considered it best, because we were already then convinced that clean weeding was not, even on flat land, the best system for preserving the topsoil, but because the times were critical and clean weeding was generally considered the cheapest. Since then our knowledge has again increased a lot, and we can now condemn the clean-weeding system in all respects and from whatever angle it is considered."

Bold, uncompromising statements some of those I have quoted in condemnation of clean weeding, coming as they do from two acknowledged authorities in scientific tropical agriculture, which I commend to the notice of the champions of that system and invite their opinions here or elsewhere in refutation of same.

Nor are these Dutch agricultural professors alone in their strong recommendation of ground covers versus clean weeding, for we find H. C. Pinching, Senior Scientific Officer of the Rubber Growers' Association, F.M.S., in a lecture entitled "General Principles of Economic Planting," delivered at Klang in September, 1922, voicing much the same opinions. After quoting from Herbert Wright's book "Hevea Braziliensis," in which the author champions clean weeding as the only practical system, Mr. Pinching stated the following:—

> "Several years have elapsed since this was written, and I think that the evidences which have accumulated during these years show that while clean weeding may or may not be the least expensive policy in the long run from the actual expenditure point of view, yet it has a most marked detrimental effect upon the soil, and consequently upon the rate of growth of the trees. I know of hillsides which have been clean-weeded for twelve years, and where now the weeds will not grow—and I might add, neither does the rubber."

The views expressed by the author of "Hevea Braziliensis" on the matters we are discussing to-day, and which, though written some twelve years ago, still represent pretty accurately the views held by him and most Ceylon planters, are of special interest as representing the diametrically opposite opinion to those of other agricultural scientists from which I have already quoted. Though allowing that "it is impossible to exaggerate the soil loss that must take place" from clean weeding, and its "appalling effects on the soil," Mr. Wright comes to the conclusion that nevertheless it "seems to be the most desirable system from the

commercial point of view," and that the disadvantages of growing green manures amongst cultivated crops completely outweigh the advantages.

On the other hand, a growing preference for cover crops or selected weeding has been for some time evident in practically all reports from the various British visiting agents in Java and Sumatra, most of them Ceylon-trained men who came to us wedded to the tradition of clean weeding, but I think, almost without exception, now converts to the advantages of keeping the soil covered. For instance, Mr. Roger Bannerman, a well-known visiting agent in Java, circulated some time back amongst the estates he visits an excellent memorandum on " Green Manures and Green Covers " which is well worth perusal. Another, Mr. W. E. Dickinson, in a late report on a Java tea estate which had suffered badly from Helopeltis, attributed the causes of the pest more than anything else to clean weeding, which he refers to as " the best method of creating wash in the wet weather and dry wash in the drought," and condemned the " injurious effects of the exposure upon the food substances in the soil."

In this connection it is interesting to recall that the first agricultural scientist who openly and consistently preached the benefits of cover crops and green manures hailed from Ceylon. I refer to Kelway Bamber, who, when I first met him in Java twenty years ago, was a strong advocate of those systems, and, as I see from references to him in the Ceylon press, is still so to-day.

To properly appreciate the use and beneficial effects of nitrogenous cover crops upon the soil, and their manurial influence upon the cultivated product on the area under treatment, it may be useful to refer to the process that takes place.

Leguminosæ as a family are recognisable by the nodules on their roots, which in some varieties are more pronounced than in others, and the size and number of which vary considerably. These nodules contain large numbers of bacteria whose existence is closely connected with that of the *leguminosæ*, both of them benefiting from the combination. The bacteria of the nodules extract free nitrogen from the air, which then finds its way along the stalks to the leaves of the *leguminosæ*. In due time these leaves fall off, form a humus layer, and give the nitrogen back to the soil by a complicated process in which, with the assistance of various soil bacteria, the albumen is converted into nitrates, in which form the nitrogen is absorbed by the roots of the tea or rubber. It is through this process that *leguminosæ* gradually re-fertilise the soil after being grown on it for periods the length of which depends a good deal on the quality of the soil.

With regard to the important matter of which are the best varieties of cover plants, this is a matter that depends largely upon nature of soils, condition, age, and planting distance of the cultivated trees at the time of treatment, elevation of estate, and other varying conditions. Scarcely a season passes without the

addition of new names to the long category of plants that come under the head of ground covers or green manures.

It is an interesting fact that of those most in favour at the present time many of them—as, for instance, *Vigna* and the *Centrosema* varieties—were quite unknown in the ordinary planting circles ten to fifteen years ago, whilst many of those we used in our earlier rubber clearings have gradually been superseded by their more fashionable rivals. In the place of the Kratok (*Phaseolus Lunatus*), Clitoria, Passiflora and Indigofera varieties, and other old friends of those early days, our Scientific Officers and Visiting Agents nowadays descant chiefly upon the comparative virtues of Vigna, and the different varieties of Centrosema, Tephrosia, and Crotalaria, only the last-named two of which were in use in the days I refer to. For the purpose of prevention of wash and protection of soil rather than for their nitrogenous properties, Vigna Oligosperma, Centrosema Plumieri, C. Pubescens, and Mimosa Invisa seem to be most in favour at the moment, whilst the *leguminosæ* most in favour for their nitrogenous properties are, perhaps, Crotalaria Anagyroides, Crotalaria Usaramoensis, and Tephrosia Candida, whilst on many estates Lamtoro (*Leucaena Glauca*) still does good service in this direction, as it did in the early rubber days in Java.

Of the former class Vigna Oligosperma, if once established, seems to be giving the best results. It thrives better than C. Plumieri under shade, whilst at the same time standing a drought better; also it will establish itself on soils where the Centrosema requires the assistance of manure to do so. During the period it is establishing itself the upkeep is somewhat expensive, as it is necessary to eradicate harmful weeds, and especially all grasses, carefully by hand so as to avoid the destruction of the young Vigna plants. If the Vigna rootlets are put out in the beginning of the rainy season the plant will, under favourable conditions, have taken complete possession in six to eight months, and few, if any, ground covers so effectively prevent wash, even on steep lands, as Vigna, whilst when once established the costs of upkeep are trifling, as shown by the Java figures I have already quoted.

Of the Centrosema varieties, C. Plumieri has a higher percentage of nitrogen than Vigna, and is notable for the abnormally large amount of bacterial nodules on its roots. The ground must be absolutely clean before it is planted, and must be kept clean while the Centrosema is establishing itself—say, during the first four months—but when it has once taken possession weeding costs are quite small. Unlike Mimosa, it is not capable of suppressing Lalang without assistance, nor does this variety grow well on land which has suffered much from wash, nor in low or wet lands. It thrives in moderate shade, but dies off automatically as the shade becomes dense. On one estate I am connected with it had to be discarded owing to ground borers, and its place has since, I believe, been taken by Vigna. Another variety of this order, which has been strongly recommended by some of the Scientific Officers in Java, is C. Pubescens, for which it is claimed that it masters all weeds, including Lallang, and, though a strong climber when tackling Lallang and similar growths, does not climb

up Hevea trees. It grows well in shade, does not die off in the dry season, and makes a sort of canopy about one foot from the ground which keeps the soil underneath cool and damp in the driest seasons.

Mimosa Invisa, or the Giant Mimosa, has of late years probably been the best known and most used ground cover in Java, and also on estates in Malaya where this system is in vogue. It will grow on most kinds of soil, and from sea level to a fairly high elevation, but does best at a low altitude and with not too heavy a rainfall. In its formation of heavy layers of humus Mimosa is hard to beat, whilst for smothering and suppressing Lallang it is second to none of the ground covers at present known; but it does not thrive under heavy shade. The danger from fire in dry weather and its thorny characteristics, which interfere with the tappers if it is allowed to grow near the rubber trees, make it advisable to confine it to the space between the rows of Hevea, and to some extent detracts from its value as a complete ground cover.

Of the more nitrogenous varieties of *leguminosæ*, Tephrosia Candida and Crotalaria Anagyroides are the popular favourites of the present moment. They are both easy to establish in most soils, and do fairly well under shade. They should be lopped every four or five months, and yield a large bulk of green stuff which should be used as a thick mulch to check the growth of weeds, and periodically dug into the soil. For rubber and tea estates with washed-out, poor soil, it is recommended to plant these two varieties, and after two to three years dig them out and plant Vigna, but if the soil is very sterile they may require a little manurial assistance. Until lately Crotalaria Usaramoensis was the variety most in use, but it is being superseded by the several varieties of Crotalaria Anagyroides, which are faster growers and therefore more able to hold their own against their weed enemies.

I think the fact is often overlooked that its soil is the most valuable asset an estate possesses, and that to preserve it is worth almost any sacrifice, even to the extent of the slightly retarded development of the cultivated trees, which is sometimes advanced as an objection to alien growths, though, I think, without much justification.

A matter of interest which is closely concerned with this question of soil erosion which I have attempted, I fear very inadequately, to deal with here, is the future policy of the various Eastern Governments with regard to protection of vast areas from the wholesale denudation of soil that attends native cultivation in every country alike. True, this is a matter that in a way lies outside the province of our subject to-day; but it is one which must force itself to the front before long, and is bound to be affected by the conclusions and methods of the European planters in the country where it is under review.

Gentlemen, I feel I owe you an apology for having occupied so much of your valuable time, but my object has been to collect and place before you as much of the evidence and current opinions of those who have made a special study of this subject as it was

possible to do within the limited time at my disposal—no easy task with a subject on which there has been so much written and spoken in late years, and with regard to which such very conflicting opinions still exist. If, however, this paper may, as I hope, have prepared the ground for an exchange of views here or elsewhere upon a subject which I venture to think is of more vital importance to the future of Tropical Agriculture than almost any other, it will, I venture to think, have served a useful purpose.

DISCUSSION.

The CHAIRMAN: I am sorry, Mr. Bingley, that I do not feel qualified to comment upon your most interesting and valuable paper as I should have liked, because although my experience has been entirely of Ceylon my information in regard to planting, in view of the fact that I am primarily an estate agent and was a merchant in Colombo and not actively engaged in planting, is necessarily second-hand. I may, however, say that there have been in Ceylon advocates of "selected weeding," as you call it, and although their opinions have been very strongly controverted, and the majority of the tea planters at all events have always been in favour of clean weeding, there can be no doubt, as you very justly observe, that it does inevitably lead to a very great destruction and loss of the top soil. Of recent years I think I may say that Ceylon, however, has become fully alive to the extreme value of nitrogenous cover plants. *Tephrosia Candida* is grown almost universally now and mulched into the trees at suitable intervals, and there is no doubt in my mind that this, taken in conjunction with the universal recognition of the necessity for good drainage combined with good silt pits, and the care that is always exercised to prevent the coolies from scraping the soil instead of hand-weeding, points to the fact that it is universally recognised that the preservation of the soil of the estate is, as you truly remark, one of the principal considerations that should be the care of the practical planter.

I am sorry we have not present this afternoon a practical Ceylon planter, who would be able to put forward much more ably than I can pretend to do the claims of clean weeding, but I dare say that those who have had experience in the Federated Malay States will be able to give us some very useful information on the subject.

Mr. CYRIL BAXENDALE: As far as the Federated Malay States is concerned, I think the consensus of opinion remains in favour of clean weeding. A great many of the Federated Malay States rubber estates are on the coast land, where the land is almost as flat as this room and only a few feet above sea level, so the soil siltage question does not arise on these. The tendency of much of our soil there is to have too much vegetable matter in it. I confess I am an unrepentant clean weeder for that soil.

Where I have tried cover plants in a small experimental way, and where I have watched it among my neighbours, we have found that the cover plants shut out the sun and the air, and what I want to do with soil which contains something approaching 20

or 30 per cent. of *humus*, closely resembling but not quite coming under the text-book description of peat, is to ventilate it and not cover it up. I want it to get sweet, and wind and sun are very great factors in sweetening the soil. The difficulty of selected weeding is that the weeds that grow best are, unfortunately, the worst weeds, and it is very difficult to go round and get rid of them unless we make a clean sweep. There is one weed we usually ignore, and that is " volliker pillay," which contains over 90 per cent. of moisture, and in dry weather this dries up and disappears. In my old coffee days we wasted a fearful lot of money in trying to get rid of it. This weed is quite harmless to rubber, and the Tamil cooly uses it as a vegetable.

We consider all other weeds practically obnoxious at the present time. In certain areas we have allowed weeds to grow, and dig them in occasionally, but on the whole we find the expense is greater than with clean weeding. We have got that down to from 10 to 20 cents per acre.

Mr. Bingley : Per month?

Mr. Baxendale : Yes; and so, as far as expenses are concerned, it is really not worth very much consideration.

Mr. Bliek : Allow me to say something in favour of selected weeding, although it may not be necessary after I have heard Mr. Bingley say practically all that is to be said on the subject. But after what Mr. Baxendale has told us about his experience in the Federated Malay States, he may allow me to say something about my experience with ground covers in Sumatra, although I have only had experience with ground covers there for six or seven years. After having been in former years a planter who was fully in line with Mr. Baxendale, now as regards clean weeding I have been converted. This was some years ago, and was brought about not only by reading, but after my own small experiments.

We have planted cover plants and followed the system of selected weeding, and have dropped the system of clean weeding on hilly or undulating estates, and I say the experience we have had has given a good result, for after we have planted these cover crops all wash has been thoroughly stopped, and there has not only been a regular increase in rubber crops, but also in dry weather as well as after heavy rains, there has always been moisture, and floods have entirely disappeared.

As to flat estates also. It is difficult to explain that there it is necessary to plant cover crops, but I have seen there *Hevea* plantations with their crops going yellow, and after planting cover crops of Mimosa we have shortly found a great improvement, and the trees have had much green foliage. It is hard to say whether the green foliage would not have been there without, but it was certainly there. As to the cost of upkeep, I may say that cover with Mimosa costs us so little that we can do without 50 per cent. of our people who would have been otherwise necessary, and can put them on to tapping. Some Federated Malay States planters object that Mimosa is so thorny that men and women would not enter because of the thorns. We have learned

things from the war, and we gave the coolies putties and shoes, and after that there was no trouble about it.

Mr. Bingley: With reference to what Mr. Baxendale has said, I do not know whether he is quite correct in saying the consensus of opinion in the Federated Malay States is in favour of clean weeding. I wrote recently to a friend—a well-known F.M.S. planter now home on leave, who was, I thought, a clean weeder, and he wrote back saying that cover crops were rapidly gaining ground in the Federated Malay States; and Mr. Pinching I have also quoted. Mr. Baxendale referred to the difficulty of selected weeding, inasmuch as the most injurious weeds flourish most luxuriantly; but I assure you that for many years on an estate I was manager of, selected weeding, by which I mean the taking out of all harmful weeds, which include all varieties of grass weeds, and leaving the others, was carried out with most successful results.

Mr. Baxendale: What weeds are left after you cut out the grass? We have very little but grass.

Mr. Bingley: I am surprised. I should have thought you must have other varieties besides grass weeds. About that question of aerating and sweetening your soil, I quite follow your argument, but we also claim for these nitrogenous cover crops that they have the effect on the soil of deep tillage. They open up the soil and they let air in, and that is one of the many advantages we claim for them. I cannot help thinking if on that land you speak of, which has an excess of vegetable matter, you would give this system a trial you would find it would aerate and sweeten the soil rather than the opposite.

Mr. J. G. J. A. Maas: I think we must make distinction between young gardens and old gardens. The disadvantages of the clean weeding system are far greater in young gardens than in old gardens, where the trees are growing through the whole soil and old branches are falling and acting like cover crops, and so on. I can say about Sumatra that in young gardens in the past few years, when it was necessary to bring down costs as much as possible, clean weeding was adopted on the East Coast at first, but because it was found cheaper than clean weeding, cover crops have been adopted again in most estates there. A great difficulty is to find cover crops that will grow, and it is a matter for experiment. I think the practical man in Sumatra at the present moment thinks it is cheaper to plant young gardens with cover crops than to keep them in clean weeding.

Mr. Baxendale: I spoke just now of the concensus of opinion in the Malay States favouring clean weeding. I was out there last year, and formed considerable justification for this opinion. In Perak and Selangor I saw what amounted in the aggregate to a very large area, mainly owned by natives, practically abandoned to weeds and undergrowth. On many holdings the

" passion " creeper, which used to be a favoured cover crop, was growing over the tops of the rubber trees.

Mr. BINGLEY : Is that Lallang?

Mr. BAXENDALE : Yes, and other things. The battle was going on, here one weed and there another weed struggling against it. The vast bulk of the yielding rubber in Malaya has been and is being grown, I should certainly say, on the European-owned estates that have been cultivated under clean weeding, and remain so at the present time.

The CHAIRMAN : If nobody has any further comment to make, I think I shall be expressing the desire of everyone if I first of all thank Mr. Bingley for his valuable and suggestive paper, and again I would like to express regret that we have no one here who can take up the cudgels whole-heartedly for the clean weeding system in Ceylon—a system which is also, I imagine, mainly favoured in the Federated Malay States. I cannot help thinking after listening to this discussion that the various speakers have rather spoken in regard only to the places and soils with which they are most familiar, and I think it is possible therefore that circumstances alter cases, and that it is impossible to dogmatise on this subject. I think that in very many places selected weeding seems to be an extremely difficult thing to compass, although, as I say, the planting of a particular nitrogenous plant of low growth is and has been of late years, I think, almost universally recognised as most desirable. I think that when we have the opportunity of reading Mr. Bingley's paper, when it is ultimately in print, we shall find it will add very considerably to our knowledge of the subject, and will undoubtedly enable us to consider it more closely and carefully than has been possible this afternoon. We thank you, Mr. Bingley, for the paper you have read to us.

PURE PLANTATION RUBBER FOR THE SOLES OF FOOTWEAR.

By A. OLIPHANT DEVITT.

Mr. P. J. Burgess, who presided, said: It is my pleasing duty to introduce to you Mr. Oliphant Devitt, who is going to read a paper to you on "Pure Plantation Rubber for the Soles of Footwear." It needs very few words to introduce Mr. Devitt, who is probably better known than anybody else as having been so largely instrumental in introducing this new method of soleing boots and shoes and in popularising the use of crepe rubber for the purpose. We look to this use for very considerably increasing the consumption of plantation rubber, and I am sure the thanks of the plantation industry are due to Mr. Devitt for the work which he has done in this direction.

Mr. Devitt: Mr. Chairman and Gentlemen, first of all I would like to thank you, sir, for what you have said about me.

I think it will not be out of place to begin this paper by giving a few interesting details of the very earliest days of rubber.

It is curious that one of the very first uses to which rubber was put was footwear. Rubber was first known to the civilised world in about 1525, and later on after Christopher Columbus' second voyage, a book was written by a certain Juan de Torquemada in 1615, in which this gentleman gives the interesting information that the gum of the rubber tree, or weeping tree as it was then called, was made into shoes. The Indians on the Amazon to this day smoke the latex on the clay cast of a foot, thereby making a thick pure-rubber sock or boot. These they decorate by denting in patterns with a sharp instrument.

In 1730, in England, a certain Dr. Priestly noted "a substance excellently adapted for wiping out from paper the marks of a black-lead pencil." It was not until 1823 that Mackintosh introduced his waterproofs still called after him, but there is no doubt that the natives of the Amazon waterproofed their blankets or cloaks with rubber long before this. The first shoes made on a commercial basis in the civilised world were introduced by Goodyear in America about 1845.

In 1836, when the production of rubber only amounted to some 200 tons, and up to 1880 when we had about 600 or 700 tons in England, it was all being used for boots and shoes, mechanical purposes and for waterproof coats.

From 1890 rubber bicycle tyres consumed an appreciable quantity of the production. In 1907 we may say the motor-car tyre first became an important new use for rubber, but any rubber

previous to 1900 was wild and native collected, not only from the Amazon, but from all parts of the world.

In 1900 the production of plantation rubber was only four tons. In 1910 it was 8,200 tons—in 1920 the crop had increased to 372,700 tons, and last year, in spite of restriction, some 370,000 tons were harvested.

We must now turn to the subject of this paper.

The old pioneers who planted up the first areas of rubber in Ceylon were the first to realise the wearing qualities of pure plantation rubber for the soles of their boots and shoes. They fixed very thick and somewhat rough crepe, usually brown, on their shoes, and found out not only the comfort it gave on the rough estate roads but the extraordinary time it lasted.

It was not until 1921, at the Rubber Exhibition at the Agricultural Hall, London, that the first pure-crepe soles were shown in the Ceylon Section. These were of fine quality crepe, but were very thick and rough compared with the fine article produced to-day.

Why Ceylon was the actual birthplace of this great business is interesting. When plantation rubber was first made into crepe form, the Ceylon planters used their tea driers to dry it, and it was then rolled into thick sheets, known on the market as golden blanket. Malaya only made thin crepe which was air-dried.

At the exhibition one or two members of the boot and shoe trade saw the Ceylon samples, and one in particular, a member of an old-established house of high-class tennis-shoe manufacturers, was very enthusiastic and saw the possibilities of this new material.

I was lucky enough to be coached and taught by this gentleman what was wanted for the sports shoes of this country (Great Britain), and in August, 1921, wrote a circular giving as much information as was then available, not only for the guidance of the planters in the East for making what was required, but also pointing out the possibilities from the manufacturers' point of view.

My firm sent out some 2,000 of these circulars all over the world, and I must say this was really the start of a new use which has and is progressing by leaps and bounds all over the universe.

As may be imagined, there were many great difficulties in the early days, probably the greatest was the fixing of the raw-rubber soles to the boots or shoes. The direct sticking with solution of the rubber $\frac{3}{8}$ of an inch thick was not satisfactory, and a great many shoes were returned with the toe coming away.

Early in 1922—this date is rather important—the method of solutioning *and* sewing one layer $\frac{1}{8}$ of an inch thick on to the shoes and then adding another $\frac{1}{8}$ or $\frac{1}{4}$ of an inch on top was adopted. This was sticking rubber to rubber, and the lower sole covered up the stitches on the wearing surface and proved eminently

satisfactory, and is, in fact, in almost general use to-day, especially for golf and tennis shoes.

The sewing also caused trouble, as the usual waxed thread cut the rubber, and I believe specially loose strand soft cotton thread, soaked in solution, is proving the most satisfactory.

Direct sticking without sewing or building up is still successfully done by many manufacturers, especially for the lighter sports shoes.

Having briefly touched on the past, we must now turn to the present and the future, which are far more interesting and vastly more important.

The Present.—We must congratulate ourselves and not forget firstly the planters whose lives we have made a burden to produce what we want, and secondly, those manufacturers who have recognised our troubles and worked hard and incessantly to use and develop this new use and give the great public everything we claim for our rubber. After about two and a-half years of hard work only about a dozen estates are turning out what may be called A1 material.

It is no easy matter to exactly regulate thickness and surface in the far East with native labour. Also the curious variation in the behaviour of the newly-made crepe, not only in the estate factory, but on the way home, causes a good deal of trouble.

Also at one time manufacturers mostly called for $\frac{5}{8}$ inch thickness and only very little $\frac{1}{4}$ inch—later they wanted $\frac{1}{8}$ inch, and that was all the rage.

In early days most machines in the East could make sheets no larger than 26 inch by 9 inch, but those who were lucky enough to have large mills, turned out sheets 36 inch long and 13 inch wide, which were found to be much more economical in cutting. Consequently, the 26 inch by 9 inch size was displaced, and this, too, caused disappointment and some loss to producers.

However, such estates that realised the great future for sole crepe quickly installed special machines, and the 36 inch by 13 inch sheets are now practically the standard. Exact thickness is now much more general, and this is standardised to $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, $\frac{1}{4}$ inch, $\frac{5}{16}$ inch and $\frac{3}{8}$ inch thicknesses, but it must be realised that it is quite impossible to get the mathematical exactness of vulcanised rubbers.

Surface.—This must be standardised by estates. The deep corrugated crepe, mostly used for golf shoes, is made by the differential creping rollers, but when these get worn, which does not take long, the corrugations become less and more shallow. Deeply corrugated sheets are $\frac{3}{8}$ inch thick. The $\frac{1}{4}$ inch is only slightly corrugated, but is also made smooth. The lighter $\frac{1}{8}$ inch and $\frac{3}{16}$ inch sheets are always practically smooth.

The cutting of the sheets is entirely a manufacturers' affair, and he must be the best judge how to arrange his knives to use the greatest surface and save waste. It may be useful to mention that the waste is readily saleable, and roughly fetches a fraction

under standard crepe on the London market. Many manufacturers make their own sticking solution out of their waste cuttings.

To leave crepe for one moment.

Smoked Sheet.—A clear dark rubber with diamond ribbing is being used for some makes of Plimsolls or beach and gymnasium shoes, but crepe is really more serviceable and of much more attractive appearance.

It is a little difficult to give really reliable figures of the supply during the past year, but I think we are quite safe in saying anything between 2,000 and 2,500 tons direct from the plantations have been actually cut up and used on footwear during 1923.

As can be imagined, a very considerable quantity of sole crepe, quite unsuitable for one reason or another or only partly suitable, has been sent home. This was chiefly estates' first attempts, and has been difficult to market. We did not want inferior quality to go out to shoe manufacturers and spoil or set back this new industry. When inferior or faulty lots were sold, we could not guarantee that they would not be planted on some poor shoemaker who did not know the material, but was keen to try the new stuff that was being so much talked about.

However, practically all the old stock has been sold, and shipments are now coming in much more even and are nearly all in the large-sized sheets. I have here a sheet which is a great improvement on what was being sent over two years ago.

A great deal has been said and written about re-made crepe—that is, ordinary market crepe re-milled in this country or elsewhere and built up to the necessary size of sheet and thickness for shoe soles. This re-made rubber, although undoubtedly serviceable when properly manufactured, cannot compare with that made on the estates for wearing capabilities, and it is important that the two totally different qualities, viz., (1) estate produced and (2) re-made, be kept separate and only dealt in for what they are and only sold as such.

Mr. Baxendale: What do you mean by re-made?

Mr. Devitt: The ordinary standard stuff taken and worked up. It is not "reclaimed" rubber. Our point is that you cannot re-make it and put it back to what it was before.

In America a very fair quality sole is being made up, from latex I believe, for the cheap canvas shoes, and is quite satisfactory for this purpose, but here again it cannot be compared with estate-manufactured crepe.

The quality now being produced is reliable enough for estates to make sales for future delivery, and probably 500 or 600 tons of the 1924 crop have already been sold, part for delivery here in England and part for direct shipment from the East to the United States and Canada, to Australia, to South Africa and to European countries. These contracts provide for monthly deliveries or shipments for three, six, nine or twelve months

ahead. Deliveries have been good with very little cause for complaint.

Of course this selling for future delivery is good from the manufacturers' point of view because it ensures his supply and enables him to work out his costings for long distance orders. For newcomers to the market it is not so good, as it reduces the supply of available rubber on the spot as arrivals are much depleted to satisfy forward contracts.

At the annual London Shoe and Leather Fair in 1921 there were only two pairs of shoes with crepe soles shown, but in 1923 there was practically not a stand that did not make a special feature of some type of footwear with the new crepe instead of the old-fashioned vulcanised-rubber sole.

Now to the Future.—The past has shown us an increase of a few pairs of soles in the summer of 1921, to some 2,500 tons in 1923, all of which has been used, and I estimate about 500-600 tons of the 1924 crop has already been sold.

I do not look for a very great increase in production for 1924, but I think enough will come along to satisfy all likely demands for the present.

Estimates, of course, may be very much upset as a result of the propaganda campaign of the Rubber Growers' Association. As far as Europe is concerned, one circular recently sent out resulted in over 5,000 enquiries in about fourteen days from people interested. These people were for the most part in the shoe trade and not merely inquisitive private individuals.

The Propaganda Secretary of the Rubber Growers' Association has recently spent some weeks in America, and has met with very great encouragement in that country as to the possibilities of crepe soles.

America in 1919 produced 75,400,000 pairs of rubber boots and over-shoes, and no less than 138,468,770 pairs of rubber heels. In 1921 her output of all rubber boots and over-shoes had increased to 96,387,908 pairs.

Of her production in 1923, America exported 4,737,300 pairs of rubber boots and shoes and shoes with rubber soles, and during 1923 she used no less than 15,800 tons for rubber footwear of one sort or another.

One firm imported into Brazil—this is rather interesting—the original home of rubber, 500,000 pairs of canvas shoes with rubber soles in the year 1920.

Spain, somewhat backward in such things, reports the importation during 1921 of 50,000 kilos of rubber-soled footwear.

All the above rubber goods were vulcanised, *i.e.*, compounded in varying proportions of pure rubber and filling materials.

From these few facts, it is easy to see the possibilities of crepe, especially as it has been proved that pure rubber outlasts any vulcanised and mixed compounds.

At the present moment all countries of the world are interested; regular shipments are going to North and South America, South

Africa, Australia, New Zealand, Japan and China, besides all Continental countries.

The uses are manifold. Not only has the material been proved eminently successful for tennis, golf, gymnasium, fencing, badminton, yachting and other sports, but for ordinary everyday wear on black or brown footwear.

The Swiss army are testing several thousand pairs. The Mount Everest expedition, both the mountaineering and filming parties, are taking out boots shod with pure crepe. Many big-game hunters have found it invaluable for their purpose.

Rubber-soled sandals for the teeming thousands in India, Japan and China are more than an idle suggestion. The possibilities for workers on their feet all day, such as vehicle conductors, tube and railway porters and guards, police forces and postmen, to say nothing of the armies and navies throughout the world, are unlimited.

An interesting test is now being made in Scotland, where a number of postmen in rural districts have been equipped with crepe-soled boots.

The British Government has already stipulated plantation-produced crepe for the soles of 40,000 pairs of experimental rest and other shoes for His Majesty's forces, and larger contracts are in view.

The world's schools are other outlets where the use of something sound and of undoubted lasting quality will be and is a god-send.

You will no doubt forgive me if this paper is not as technical or as extensive as it should be, but my part of the business is entirely from the raw rubber point of view.

" Brevity is the soul of wit,"
But crepe is the sole of man.

APPENDIX.

The following particulars of the various uses to which Pure Plantation Crepe Soles are already being put are not only interesting but show the enormous possibilities in the future for this material.

Tennis.—Tennis shoes were the first sports shoes on which crepe soles were fixed, and these have proved their remarkable wearing qualities, especially on hard courts. The following champions of the game have testified their satisfaction :—Mlle. Lenglen, Miss McKane, J. O. Anderson (New South Wales), Major A. R. F. Kingscote, R. Lycett, B. I. C. Norton (South Africa), G. L. Patterson and P. O'Hara Wood (Australia).

Golf.—There has been no greater success for crepe than for golf shoes. The following are some of the champions who use and express in no measured words their approval of the material and its behaviour under various conditions :—Miss Cecil Leitch

and Miss Joyce Wethered, Roger Wethered, J. Braid, George Duncan, Alex. Herd, Edward Ray, Harry Vardon and James Ockenden. Pure Plantation Crepe Soles are to be seen on every golf course throughout Great Britain and on many others in all parts of the world, particularly in India.

Cricket.—For grip and durability, combined with lightness and comfort, Crepe Soles have been found very satisfactory for cricket shoes, but comparatively few are in use so far.

Bowls.—Crepe Soles for this game have proved exceedingly good; there is no slipping, there is comfort to the wearer and the rubber in no way damages the bowling greens.

Badminton.—This game essentially requires light, strong shoes capable of standing great strain, and Crepe Soles have proved eminently suitable.

Rackets and Squash Rackets.—The same remarks apply as to Badminton.

Gymnasium.—The light canvas shoes with Crepe Soles, retailed at quite a moderate price, are now used by thousands of gymnasts, and the long life they have is a very great consideration to their users.

Fencing and Boxing.—Although we have no actual reports of any important matches being fought on Crepe Soles, they are coming into use and proving suitable, I think chiefly for training.

Yachting.—For this and also as deck shoes on steamers, nothing is better than Crepe Soles, and they are very largely used.

Curling.—The Rubber Growers' Association has just received a very noteworthy testimonial as to the behaviour of Crepe Soles on snow and ice from Switzerland, where curling is in full swing and players are speaking in the highest terms of them.

Walking.—For walking matches Crepe Soles have proved excellent; they save the great jar to the spine and are light. This is proved by the recent walk from London to York, over 200 miles, in quicker time than taken by a horse.

Rock Climbing.—Boots with heavy Crepe Soles for rock climbing both in Cumberland and elsewhere are being used, and wearers report that their strength, foothold and comfort cannot be beaten. Members of the expedition to Mount Everest are equipped with these boots, both the climbers and the cinematograph party.

Big-Game Hunting (both with gun and camera).—Here again heavy Crepe Soles are light and less tiring on long marches than leather and nails, besides, they are very silent, which is of the utmost importance.

For Fishing Brogues.—Crepe lends itself admirably and does not get stiff and does not cut or slip on the rocks. The water does not hurt them at all.

The above are principally sports uses, and the following come under the vaster possibilities of general use:—

Army.—Crepe-Soled Shoes are being used in the British army gymnasiums, but so far the actual marching boot has not been properly tested, although we claim it is a very great improvement

in many ways on the heavy leather-soled boot. The Swiss army have given a trial order, and the French and Dutch Military Authorities are more than interested.

The Police and Postal Services are a very great possible field of suitability. At the present moment postmen in certain rural districts of Scotland are putting Crepe-Soled boots to a severe test.

Railway, 'Bus and Tram Services.—For men nearly always on their feet, drivers, conductors, guards, lift men and collectors, would find the ease, long life and lightness of Crepe Soles of extraordinary benefit.

Schools.—The light canvas shoes with Crepe Soles for general school wear, Swedish drill, etc., outlast any of the vulcanised shoes now generally worn. Every parent knows only too well the expense of keeping children in these shoes.

Slippers.—For ordinary home use and for bathroom wear light makes are most satisfactory.

Beach.—For beach wear and also as bathing shoes and waders for children, Crepe Soles have proved very good, and ever increasing quantities are now being sold for these purposes.

Hospitals.—Ward shoes for nurses have proved a boon not only to the wearers but to the patients where silence is of the greatest importance.

Electric.—For use in generating stations or for electrical work, where insulation is necessary, Crepe Soles are not only satisfactory but necessary.

General Everyday Wear.—This, after all, is the greatest field for this new use. The heavy vulcanised sole, as often as not nailed on to the boot, admittedly gives considerable wear, but what with making holes through the soles and letting in the damp and the excessive weight, they have very little on balance to recommend them. Now, Pure Crepe Soles will outlast any vulcanised compounded rubber and keep the feet warm and dry, are far lighter, and when properly fixed are practically undistinguishable from an ordinary leather sole.

There is a certain amount of danger from slipping when the roads are greasy, but the new non-skid shape of sole has quite overcome this.

The soles can be coloured to match the boot, black or brown, and can be had thick, medium, or thin at will—in fact, they can be made and fitted to suit any taste.

Crepe Soles on ordinary walking boots and shoes are being sold now by nearly all boot-shops, and we foresee a very great increase in this branch in the future.

I have not touched on the advantages of Crepe Rubber Soles to the dock and warehouse workers, to coalminers, to lightermen and bargees, to the engine-room staffs and deck-hands of ships, to lorry and taxi drivers and ordinary chauffeurs, who will find the soles do not slip off the pedals like ordinary leather boots are apt to do. I think they ought to have rubber on the soles on their

boots instead of on their pedals. For gardeners and farm hands nothing is better.

I might go on with uses *ad infinitum*, but those I have mentioned should make people think, and, I hope, help to develop the greatest thing in rubber since the first pneumatic tyres, and the greatest thing in the shoe trade for the last fifty years.

DISCUSSION.

The CHAIRMAN: Gentlemen, I am sure I shall only be voicing the views of all of you when I thank Mr. Devitt on behalf of the Conference for the very interesting paper which he has put before us. It is a paper on which I hope there will be quite a full discussion, and if any opponents of the crepe rubber sole have points which they would like to put to the meeting we should be only too glad to welcome them and give full facilities for the discussion of crepe as against any other form of sole, whether leather, vulcanised rubber, or any other kind or description.

There are many points on which one might touch. Perhaps one of the most important is to consider what market there is for this soleing of civilised people's boots. A very conservative estimate of the number of people in the world who are able to buy the civilised form of boot and who might be looked upon as potential users of crepe soles may be taken as between 300,000,000 and 400,000,000. At present the consumption of crepe rubber for soles is something in the neighbourhood of 2,500 tons, and taking the consumption of rubber as 1 lb. for each pair of soles, that will be sufficient to equip something like 5,000,000 pairs of boots; so you can see that if we look at the future possible consumption as being equivalent to the requirements of 300,000,000 people we have not yet touched more than between 1 and 2 per cent. of the problem in front of us.

Mr. Devitt has referred to the question of slipping. Now, it may be worth while to consider this point very closely indeed, because from my own personal experience that is the only one drawback at present to the use of these soles, and although various methods have been tried to overcome the difficulty, I think the best and simplest of all, if anybody is troubled with the slipping of the sole, is to take an ordinary sharp household table knife and cut deep grooves across the soles of the boots. I have my own done in that way, and I shall have pleasure in showing any gentleman who likes to see the sole cut in that way. In fact, I am wearing one now. I have one sole cut in ribs and the other left plain, and whenever there is a greasy pavement I take delight in noting how one slips and the other will not slip.

Mr. BAXENDALE: Will the Chairman kindly lay his foot on the table?

The CHAIRMAN (complying): Do not cut too deep. The other sole is plain. One slips and the other does not. As Mr. Devitt

points out, it is not when the day is very wet that it slips—it is all right in a torrent—but the trouble arises when we have a damp, greasy day. Probably we have more of those in London than they have on this side of the Channel.

I hope we shall have a full discussion of the merits and the demerits of the crepe sole.

Mr. BAXENDALE: Arising out of the paper, in view of the possibilities of the extension of this industry which have been so lucidly explained to us by Mr. Devitt—and as far as my limited experience goes I agree with him—I should like to ask why he expects no development in the current year. Why should it suddenly practically stop? In passing, I should like to observe that I was curling in Switzerland this winter, and at the Engelberg Club I was asked if I had crepe soles with me. It almost appeared to be a condition of membership!

Mr. DEVITT: I meant to say I thought there would be sufficient rubber for immediate needs, but in the near future I do not think there will be anything like enough to go round unless producers come along with suitable stuff quickly.

Mr. BAXENDALE: It would be rather a pity, if you do expect a great extension, to say anything to discourage us from producing more.

Mr. DEVITT: Two years ago, when this was started, I was in communication with something like 200 estates, giving them samples and details of what was required, and after two years there are only about 12 estates making really A1 stuff. But the number is increasing, and quality is improving, as these samples before you show; and a much bigger quantity is coming on from estates. But many estates chucked up the sponge after sending their first attempts home, and which were not good in quality and consequently did not find a ready sale; but some of these are producing again. It is not right to expect a great increase for, say, six months. After that I expect more. I mean good stuff. I would rather have 5 lbs. of good stuff at first than a big quantity of material that is not suitable. It is a danger to the trade and the success of the enterprise if we get a lot of inferior stuff along. An inexperienced manufacturer would probably use unsuitable stuff, and it would do harm.

Mr. BAXENDALE: You do not appear to be encouraging the production.

Mr. DEVITT: I am encouraging it for all I jolly well know, but we do not want people tumbling over each other and sending inferior stuff. These two sheets—(on the table)—are prize-winners, one from Sumatra and the other from Ceylon. Both are excellent, and no doubt both these estates will continue to supply this material in good quantities, and we want material we can rely upon. We cannot impress on estates too much that inferior stuff, or anything that is not up to the mark, should not get on to the market and fall into our new customers' hands, for if any-

thing goes wrong it will upset things. It would be better to starve them for a bit.

The CHAIRMAN: Was not your question referring to the paragraph in which it is stated that Mr. Devitt was expecting that the quantity this year would not be more than 2,500 tons?

Mr. BAXENDALE: Yes.

The CHAIRMAN: I think a good proportion of the quantity already disposed of has gone into primary equipment, and that many manufacturers are better supplied with the material than they were a year ago. Although the absorption of 2,500 tons is put down to boots and shoes it does not follow that that quantity has already found its way on to the feet of the future consumers. There is a stock of shoes already soled at the present time ready for purchase which there was not a year ago.

Mr. BAXENDALE: I do not think that quite deals with the situation, for the same position will occur at the end of this year. At the end of this year your retailer will require his stocks in hand as he did at the end of the past year. I hope he will require larger stocks as a reserve.

Mr. DEVITT: Were these the words you have referred to: "I do not look for a very great increase in production for 1924, but I think enough will come along to satisfy all likely demands for the present"?

Mr. BAXENDALE: Yes.

Mr. D. F. L. ZORN: Has anybody formed any estimate of potential consumption for 1924? Is it possible to name any sort of approximate figure?

Mr. DEVITT: It is absolutely impossible. It was one of the greatest difficulties in handling this business to know how much to produce and what the demand would be. Either you overproduce and work up the demand to take it, or you work the other way round. It is very difficult. During the last year we cannot have had enough or the price would not be 1s. 9d. A lot of people say it is an absurd price: "the price of standard," they say, "is 1s., and you are getting 1s. 9d. and 1s. 10d." The price is absolutely controlled by supply and demand. We do not ask the price for the rubber; the buyer comes and bids it—which is a very nice situation indeed! In other words, the demand has overtaken the supply. I speak as a broker. I am taking the basis of the buyers of good stuff—of "it" absolutely. There was and is plenty of inferior stuff sold at cheaper prices in London, but it is nearly all cleared away now, thank goodness.

If we take good quality only as the basis on which we base our calculations—and we must do this—there is only just enough for present requirements. I do not think we shall have sufficient to meet any important new demand till the turn of this year, for I do not believe it can be engineered before that. Estates cannot turn their staffs on to sole rubber and make a change so quickly.

Mr. NOEL BINGLEY: Mr. Devitt spoke about the pure rubber sole outlasting the ordinary rubber sole. Cannot you tell us,

Mr. Devitt, about the powers of the pure rubber in outlasting the vulcanised sole? We had it discussed the other day. A gentleman here rather disputed the claim put forward for the crepe sole by the chairman of the Propaganda Committee, and this speaker was also criticised by Mr. Crowther, secretary of the same committee.

Mr. DEVITT: I am absolutely certain this gristle crepe rubber will outlast any good average vulcanised sole. It will last for another reason, too; that is that some vulcanised soles have not a very regular habit of keeping good over from one season to another. Crepe soles get hard and stiff, but they never, never crack. You will find a good many vulcanised soles for which you pay a good price, which, if you lay them aside for any length of time and then bend them, will crack. I call that the wearing quality, just as much as using them on the feet.

Mr. BINGLEY: Can you give us an idea as to the number of vulcanised soles that a crepe sole will outlast?

Mr. DEVITT: No. I will not say they will outwear any three pairs, but they will, mind you, outwear three ordinary quality Plimsolls. Poor people find that their children will wear out a pair of Plimsolls in about ten days. They wear out the toes, but it has been proved over and over again that Plimsolls with crepe soles will last for a whole holiday or term and often longer.

Mr. BINGLEY: I was asking rather about the good quality vulcanised sole, which Mr. Fordyce Jones claims has 60 per cent. of rubber. But Mr. Crowther had opposite views on this point.

Mr. DEVITT: I would like to hear what Mr. Fordyce Jones has to say about it, for I want to say something about the vulcanising of soles.

Mr. FORDYCE JONES: I am sorry I did not hear the whole of Mr. Devitt's paper, but I do admit I have been some sort of opponent of the crepe sole. I am for very definite reasons—because I think the crepe sole interests, if I may use the word, are rather getting into a state of being so satisfied with things as they are that they are not going to keep abreast of the future. In the last part of the paper I heard a statement that the crepe sole would outwear every vulcanised sole, and I think it fair to challenge that and ask for proof. If Mr. Devitt takes the generality of cheap rubber soles or plimsolls his statement is good, but a very important thing has evolved within the last few months, proving that crepe rubber, even of pure grades, can be vulcanised at very low temperatures—with 90 per cent. of rubber, which I think will give a far better product for soleing purposes than the crepe sole.

I do not agree that the only objection to the crepe sole is that it slips. I think that is one of the least. I will name others. It cannot satisfactorily be sewn. Directly the sole is warm the stitches fall through. It is very hydroscopic. It is improved in this direction by adding from 3 to 5 per cent. of a colloid filler. To my mind the greatest objection is its dirty appearance. The

edges spew out. It is all right in winter; if you wear it through the summer the edges spread, and in bad weather it looks very bad. Then it is not a finished article. There are other objections. I am not looking for objections. What I want to do is to influence those who are interested in the crepe sole to see how far they can improve their product or link up with manufacturing interests to find a better article.

There are many objections to crepe sole propaganda as at present undertaken. One thing is that through their one-sided interest in it producers are alienating themselves from the manufacturers' interests, and this I think is a bad thing. We have heard of the miracles that have happened in the last two years, but miracles or new things will be wrought in the next two years in manufacture, and I prophesy that you will see manufactured soles which will be a vast improvement on anything we have ever seen yet.

I enjoyed the lecture, and am glad of this opportunity of having another go at Mr. Devitt.

Mr. Oliphant Devitt: This pure rubber sole is a new use for rubber, and that is what the Rubber Growers' Association have been trying to get at and develop for years. You say we will see in the near future enormous developments in the use of pure plantation rubber "vulcanised" soles. The Rubber Growers' Association will put a flag up as soon as that happens, if it *is* pure rubber. The Rubber Growers' Association do not want to try to bring about that every single boot and shoe in the world should have this particular material of ours, but they do want reasonably pure rubber used. You talk of 90 per cent. That is practically pure; but directly you start and use fillings it is different.

About this vulcanised rubber. You can have the most beautiful vulcanised sole, honestly made, with a minimum of fillings put in; but there is that great thing, competition, in the shoe trade as well as in everything else, and the fellow clever enough to put in the least rubber and the most fillings is the man we want to get at. Anything vulcanised can cover up such a multitude of sins in competition. I do not at this stage approve of this crepe rubber being touched up or coloured in any way whatever. A sole looking like that (pointing to the specimens) is absolutely pure.

Mr. Baxendale: Your boot-boy will colour it the first day.

Mr. Devitt: Yes, but I mean in the shop window.

Mr. Baxendale: Yes, and the next day it ceases to offend Mr. Jones' eye.

Mr. Devitt: There is no doubt at all that they have had to put a lot of fillings in to meet competition, and in dry weather some of the stick-on soles on ordinary boots shrink and dry, and when you get in the water the nails rust and the fastenings prove bad. Many of us have worn vulcanised soles with great satisfaction, but if Mr. Jones wants to take up the challenge that this pure crepe sole will last longer let him get the best pair of

vulcanised tennis soles he can find and wear them, and I will wear a pair of crepe soles, and we will keep on till the feet of one of us is seen through the shoe. The Rubber Growers' Association want as much rubber soleing used as possible, and as pure as possible. You talked about vulcanised rubber. Now you talk about pure rubber vulcanised. Well, that is all right.

Mr. Fordyce Jones: May I just point out that it is hardly fair for me to make a statement without explanations. But I am talking about some very recent developments, and I would like Mr. Devitt to have a look at these examples. They are quite transparent, and cannot remain so when mixed with fillings.

Mr. Devitt: Pure vulcanised is all right.

Mr. James Fairbairn: Mr. Chairman, I am a frank amalgamationist and co-operationist. Everybody must recognise what Mr. Devitt has done for the crepe sole. What he has done has been supplemented and increased out of all knowledge by the efforts of the Rubber Growers' Association Propaganda Department. I am not a destructive but a constructive critic, and I say the crude rubber sole must be dealt with on business lines. What I want to get you to grasp and get at soon is that you want a co-operative society (definitely, frankly co-operative), organised to market effectively the pure crepe sole.

As I conceive it, the Propaganda Department of the Rubber Growers' Association exists for the purpose of finding new uses and putting them on their feet, but not for taking them beyond the wet nurse stage. Each new use should stand on its own feet after it has been started. I suggest that a co-operative society should be formed at once, that trade marks should be registered, and that any company producing crepe soleing should be able to join it on taking out a £1 share—that is all the Company would require to invest, that the society markets the soleing for the industry under these brands, or trade marks, and that 1d. be deducted for purposes of propaganda. We have an enormous outlet for the crepe sole, and the Propaganda Department of the Rubber Growers' Association cannot stand the pressure of providing propaganda for all time.

Assuming that there is a slight increase at first on the 2,500 tons mentioned by Mr. Devitt, and that the quantity required was 3,000 tons, one penny per pound would add something like £30,000 to the Propaganda funds. It is strong co-operation we want, for marketing the sole under these trade marks, and sending it all over the world. You will then make a market for the growers and not for those who are putting in 90 per cent. of fillers.

Mr. Bingley: Mr. Fordyce Jones at the meeting when Sir Stanley Bois read his paper expressed the opinion that the producing interests are alienating themselves from the manufacturing interests. That is a very important statement, for we have been working very hard, especially in the Institution of the Rubber Industry, to bring both sides into line. We have here a gentleman who represents the manufacturers and who is sitting on our

Propaganda Committee, one object of this Committee being to promote the use of this sole, and he tells us we are doing something to bring both sides into conflict. That is a point I would like some explanation on.

Mr. Devitt: When he says "manufacturing interests" I do not think Mr. Jones means the general rubber manufacturer. I suppose he means the maker of soles.

Mr. Bingley: I suppose so.

Mr. Devitt: I do not mind that about him. Let us make him wild, it will only draw attention and cause discussion on pure crepe soles—exactly what we want.

Mr. Fordyce Jones: We cannot get away from the fact that there is opposition. It is only natural; it is one interest against another. But one thing I want to protest against. It is not really fair to call all vulcanised soles rotten soles. It does not pay to make rotten articles to-day. I know many of these soles contain from 50 to 60 per cent. of rubber. I only criticise crepe soles in the hope of improving them. I do object to the spirit of condemning the manufactured article up to the point of alienating the manufacturer. I suggest that we should not be content with the statements I have made, but investigate them. Find out on behalf of the Rubber Growers' Association what there is in what I have said, and see if we cannot make use of any value there may be in these new things, and then get the manufacturers to turn the rubber into a rubber sole at about 2s., which will have all the advantages and none of the disadvantages of the crepe sole. That, to my mind, would be the best piece of propaganda.

Mr. Devitt: One thing is certain, and that is that we must always keep the line clearly marked between stuff that is produced on the estate and the stuff that is produced anywhere else by re-making. It is said that the re-made sole rubber is as good, but I do not think it has been proved at all. You, Mr. Jones, and others have said it is just as good. I think it is a very serviceable article, and for certain cheaper shoes it is all right, and it is pure rubber, and I do not think the Rubber Growers' Association objects to that; but as soon as you get it mixed with fillers you open the way to more and more fillers, because of competition. Where people who have for years bought vulcanised soles say they will now have this crepe, it, of course, gets up against the manufacturer of vulcanised rubber soles. I do not think he is indignant; it is merely a matter of competition. I think we are only advocating the use of rubber in its purest form consistent with efficiency, whether it is made on the estates or elsewhere.

Mr. D. F. L. Zorn: I think we are to an extent discussing something that lies in the future. If I understand Mr. Fordyce Jones aright, the developments he speaks of are quite new, and his point is that before long we may see a sole evolved which will be practically a pure rubber sole, and which will be better than existing compounded soles and better than the existing crepe sole. That at present is a matter of opinion. The Rubber Growers' Association quite naturally believe crepe is the very best

thing, and obviously it is only by experiment that we can find out whether there is anything in Mr. Jones's view. For the industry at large the best thing would be, of course, to find out the very best sole that can be created, and we ought to keep an open mind. Personally, I am inclined to think it will be very hard indeed for anybody to evolve a compounded sole as good as the crepe sole; but I think we may feel grateful to a candid critic like Mr. Fordyce Jones for his outspoken statements to-day and for his work on the Propaganda Committee of the Rubber Growers' Association. It does good to have the thing thrashed out. The Institution of the Rubber Industry has been mentioned. That Institution has already in its short life provided opportunities for our getting and giving a little of this candid criticism. We have not only had the crepe sole criticised, but we have had opportunities at the Institution of criticising the manufacturers on the compounded sole of the past, and I think the effect has been to stimulate the production of a higher class of sole. Mr. Devitt has always been full of optimism and enthusiasm on this matter, and he is still so to-day, and we can certainly make use of all the optimism we can get. The crepe rubber sole is probably the best example we have in that direction.

Mr. J. G. Hay: One thing mentioned by Mr. Devitt was the cricket field. Mr. Devitt told us the crepe rubber sole had been used, but I did not hear the name of a single cricketer who had recommended it. The reason is the danger of slipping. The same applies to the manufactured sole. A slip on the cricket field is more dangerous than on the tennis court or the golf course. Till Mr. Devitt gets over that I do not think he will ever make a success of the crepe sole with cricket. If he goes to Lord's and demonstrates it there I think he may learn something.

Mr. Devitt: I think you can use it for almost anything, and players have used it for cricket on a dry day, but I admit it is not satisfactory in wet weather.

Mr. Hay: Yes, I have tried it, and it is quite a success except on a wet day.

Mr. Devitt: The Chairman has spoken about slipping. Everything slips to a certain extent. I confess I have been on my back in the middle of the road on a greasy day. But lots of soles do slip. For anybody who walks about Brussels on these cobbles and uneven pavements, even if wet, we have proved the crepe sole to be the finest thing in the world.

The Chairman: There is very little left now but to thank Mr. Devitt for his paper. We must consider rubber as a general servant of the public. We have found in plantation crepe soles something which will give very fine service at a very low cost. It should be a taking point to the public—rubber as a servant of the public. In this form, I take it, rubber will give you excellent service at a low rate. If any other form of rubber can be produced to serve better it will certainly be supported by the Rubber Growers' Association. If this discussion to-day has gone any step at all towards making the position a little clearer and has

increased the capacity of rubber for service to the general public by indicating a finer rubber article still to be put before us, we shall all agree that the discussion must be considered to have helped fill its true function. I have pleasure in proposing a hearty vote of thanks to Mr. Devitt for the admirable paper he has given us.

MEDICAL RESEARCH IN THE TROPICS.

By NORMAN GRIEVE.

The CHAIRMAN (Mr. P. J. Burgess) : I will now read the following paper on " Medical Research in the Tropics," by Mr. Norman Grieve, who is unable to be present :—

This is a very wide subject, upon which many volumes have been written, and I am conscious that, within the limits of a short paper, it is impossible to do more than touch on the fringe of it.

To those, however, who wish to pursue further this important and fascinating branch of knowledge, the indication of books bearing upon it may be of advantage, and in the course of these remarks I shall quote some of the authorities which should be consulted by those who desire to study what is undoubtedly one of the scientific movements of the day which contributes in a marked degree not only to the well-being of humanity, but, in a way that many do not realise, to the commercial and agricultural development of many parts of the earth's surface, which in past years, owing to the prevalence of disease, were closed to the activities of mankind.

Of the institutions which deal mainly with diseases most prevalent in the Tropics, the London and Liverpool Schools of Tropical Medicine, and the Rockefeller Foundation are the principal. The latter directed its attention with remarkable success to the suppression of hook worm. They have a school of hygiene in London, and in various parts of the world have spent large sums of money in carrying out the objects of the founders in the fight against disease.

I will, however, confine myself to that complaint which has been the greatest source of trouble to those engaged in tropical agriculture—viz., malaria.

Until the epoch-making discovery of Sir Ronald Ross on 20th August, 1897, which once for all demonstrated the fact that the Anopheles mosquito had the power of transmitting the germ of malaria and other fevers from one human being to another, men had been groping in the dark to find the real cause of the spread of these diseases, which were responsible for millions of deaths in various parts of the globe.

As far back as 1640 a palliative was introduced by the Countess d'el Chinchon, wife of a Governor of Peru.

The beneficent properties of quinine, extracted from chinchona bark, were then made known, and to-day quinine holds its place as the most effective remedy in cases of fever.

From the time of this discovery onward during the centuries, medical men were searching for light. What really caused the spread of these fevers remained obscure.

The name "Malaria," meaning bad air, indicates the rooted impression in men's minds that it was miasma or exhalations from swampy ground which caused fever. In the Fen country of Lincolnshire and the Romney Marshes fever and ague were prevalent for centuries. The Pontine marshes, near Rome, at certain seasons were a death-trap. In the West Indies the inhabitants were time and again almost wiped out by yellow fever, and in all tropical countries the death-rate must have been appalling. Though miasma was not the cause of the trouble, it indicated conditions favourable to the multiplication of the mosquito, and so "the pestilence which walketh in darkness" continued its fell work.

In 1878 a French surgeon, Laveran, discovered the malarial parasite in the human blood, and subsequently Manson formed the opinion that there might be a development of the parasite in the mosquito; but it was not until Ross's famous discovery that the fact was finally established that the poison was in fact carried by the Anopheles mosquito from a sick to a healthy person. From that point the real fight against the disease commenced.

The first and most striking application of that discovery which comes to one's mind is the cutting of the Panama Canal. This gigantic work had previously baffled all attempts at solution. The mosquito here took its toll in thousands of lives, and, after millions of money had been spent, the undertaking was given up as hopeless. Then America took it up, and General Gorgas, in the light of Ross's discovery and by practically a free hand as regards money, proceeded to attack the mosquito by draining the ground where possible, and, where this could not be done, by spraying damp spots with oil from a pipe-line which traverses the Isthmus. And now, on the ground where lie the bones of thousands of men who died in the earlier attempts, the ocean-going ships of the world sail proudly from sea to sea, and the Panama zone is now literally a health resort.

Other parts of the world where similar work is now being carried out are too numerous to give in detail. When I tell you that Sir Ronald Ross's book, "The Prevention of Malaria," contains the reports of nineteen workers in various parts of the world, you can well understand that the only way for those who wish to make a study of the subject is to read the book.

Dr. Malcolm Watson's account of his work in the Malay States was printed as a separate volume, and is brought up to date in the second edition of "The Prevention of Malaria in the Federated Malay States" (John Murray). I am more conversant with the work done there, as I went out to Selangor in 1911 representing the Seafield Rubber Company, when an important system of subdrainage, devised by Dr. Watson, was carried out on this property, which, so far as rubber estates were concerned, was pioneer work. As is too often the case, no financial assistance whatever was given by Government in the carrying out of this important

experiment, and the cost, which now exceeds £10,000, was borne by the shareholders of the company.

Similar schemes have since been carried out in other parts of the country to eliminate the breeding-places of the mosquito, and, where careful supervision and upkeep of the system have been maintained, diminution of malaria, and consequently better health and greater efficiency in the labour force, have resulted.

The latest report on Seafield states that in the year 1911, on a total labour force of 520, the death-rate was 144 per 1,000, and that this figure has steadily declined till in 1922—when, on a force of 670, the death-rate was 17 per 1,000—these figures testify at once to the efficacy of this remedy. I might quote the final passage of Dr. Watson's Report of Seafield for 1922:—

"In conclusion, some 12 years ago the estate was a death-trap where Europeans and Asiatics suffered, and where children, if born, rarely lived.

"To-day the estate is amongst the healthiest in the Peninsula, alike for Europeans and labourers.

"This has been effected by a system of sub-soil drainage designed expressly to meet the entomological and engineering requirements. No scheme was ever more crabbed from both aspects.

"To-day the wiseacres, who shook their heads and shrugged their shoulders, are answered."

But it must not be thought that such works can simply be carried out and then left to take care of themselves. To keep them in a state of efficiency demands constant care and watchfulness and considerable annual outlay. But it is well worth it—and, indeed, is absolutely necessary in order to maintain a healthy labour force and to make life possible for European managers and their families. And this, I take it, applies to most preventive schemes in whatever part of the Tropics they have proved to be necessary.

The Governments of the various colonies are now fully alive to the importance of keeping a constant watch on the suppression of malaria.

On 5th November, 1923, in the Federated Malay States, the Malaria Advisory Board met, and suggestions were put forward which may lead to important legislation making it obligatory on owners of land to put in force such measures as are considered necessary to keep in check the mosquito, which is the cause of the trouble, and there is no doubt that these measures will have a far-reaching effect on the health of the inhabitants of the countries where in the past this malevolent insect has accounted for terrible mortality, and consequently of great pecuniary loss.

As time goes on new facts are being constantly discovered and new light thrown on the life history and habits of the various Anopheles mosquitoes, whose activities have to be checked; it is therefore a matter of congratulation that somewhat tardy steps have been taken to found the Ross Institution as a fitting memorial to the man who made this valuable discovery, and to create a

centre in which recent information bearing upon the subject can be investigated by the best scientific brains and made available for use.

France has the Pasteur Institute, America the Gorgas Institute at Panama, so it is to be hoped that the Ross Institute, at 56, Queen Anne Street, London, will not lack the support which it well deserves.

As I said before, Ross's discovery was an epoch-making event in the world's history. It is impossible to gauge its value either in terms of human happiness and well-being or in terms of money, for it has opened up the possibilities of growing many blades of grass where none grew before, and of making many death-stricken and inhospitable regions of the earth blossom like the rose.

DISCUSSION.

Mr. BAXENDALE : A very good paper.

The CHAIRMAN : Yes. I really feel that, if it had been possible, Mr. Norman Grieve should have been here to read that eloquent paper himself.

Mr. BAXENDALE : While we entirely sympathise with the great work that has been done by Sir Ronald Ross, those of us who will remember the carrying out and the success of the work done at Seafield must consider that great credit is due to Dr. Watson and the Board of the Seafield Company, who put that work in operation. I watched it from the very beginning, and can personally testify to its efficiency.

PLANTATION RUBBER—THE ADJUSTMENT OF PRODUCTION AND CONSUMPTION.

By H. ERIC MILLER.
(Vice-Chairman, Rubber Growers' Association.)

Mr. P. J. BURGESS, who presided, said: We are now to have a paper by Mr. Eric Miller on "Plantation Rubber—The Adjustment of Production and Consumption." Mr. Miller has made a special study of this question of the adjustment of production and consumption, and what he does not know on this subject I am afraid is not known to anybody in this world. I am looking forward to hearing a most interesting paper from him this afternoon.

Mr. MILLER: Although the subject of this paper relates only to plantation rubber, it is, I think, necessary in the first instance to emphasise that the problem is one which constantly recurs with practically all commodities which are in universal consumption; but the adjustment of production and consumption of plantation rubber does present certain features which are uncommon.

We are all familiar with the popular idea of the "law of supply and demand," which is based on the principle that sooner or later, for a short time at least, supply and demand must approximately balance one another, either by increasing consumption, diminishing production, or a combination of the two. In actual practice an equilibrium is never established. So much respect is paid to this "law" that any deliberately organised effort to reduce the swing of the pendulum to a minimum is almost universally regarded as improper if not actually immoral. This feeling is doubtless based on the fear that such organisation within any particular industry can only have one object in view—namely, to secure for its promoters an altogether unwarranted profit at the expense of the community at large. There prevails a strong conviction, amounting almost to superstition, that Nature, presumed to be all-wise, has her own way of working out the law of supply and demand, which must be fatalistically accepted as being all for the best in an otherwise imperfect world, and anyone who attempts to meddle is deemed to be on dangerous ground. It is time, however, that this illusion was dispelled. Man has long since learnt to bend, within limits, the bounty and forces of Nature to his will, and the adjustment of supply to man's demand is now in the main a human problem. The secrets of Nature are to each succeeding generation a more open book than to their predecessors, and the potentialities of this world of ours are better understood to-day than ever before. The influence of

climate and soil on various agricultural products is so well known that man, in his determination to increase the available supply of any particular commodity, is able, in a comparatively short space of time, to completely change the face of Nature in the area selected for his operations. The rubber-producing industry, which is being dealt with in its larger aspect in a paper to be presented to you by Mr. Eric Macfadyen, is a conspicuous example of what I have in mind. Its development has come about within such a remarkably short space of time as to be almost uncanny. It has been claimed that co-ordinated human foresight has been responsible for thus increasing the world's supply of rubber, without which the automobile industry could not in a few short years have developed the means of rapid conveyance of passengers and goods by road which play so large a part in the world of to-day. My own conviction is that this approximate synchronisation of the expansion of quite dissimilar but mutually dependent industries is mainly fortuitous, for there is no evidence that the people engaged in developing the automobile industry have attempted to take any hand in bringing about the enlargement of the supply of rubber or of the oil which is their motive fuel. It was several years after the plantation rubber industry was firmly established before even the largest manufacturers of tyres and rubber goods acquired an interest in the production of their principal raw material. I do not imply that in this respect the rubber industry is exceptional, I am merely stating the fact because of its relevance to the subject of this paper, and to emphasise how much is still left to chance by those who embark their capital on large-scale enterprises. The risks thus taken are doubtless justified by the history of the past, but this lack of co-ordination in different spheres adds surprisingly to the difficulty of satisfactorily adjusting production and consumption of any commodity.

The plantation rubber industry has grown from small beginnings to an industry of the first magnitude with extraordinary rapidity, notwithstanding the long interval—five to six years—which must necessarily elapse between the commencement of clearing an estate and the harvesting of the first commercial crop. Therein lies the kernel of the problem we are now to discuss.

The majority of agricultural products are the growth of a single season, and whenever the supply of an annual crop seriously exceeds the demand the consequent lowering of the market price tends to restrict the area which is planted in the next ensuing season. This process of adjustment between supply and demand at times extends over two seasons, but longer than that is exceptional. In the case of manufactured goods adjustment is even more rapidly attained; but I need not enlarge upon that.

To revert to plantation rubber, we have five or six years between the commencement of an estate and the harvesting of the first commercial crop, whilst another four or five years' development must take place before the trees are in full bearing—thus a period of ten years in all, truly a long time. Rubber will not thrive outside the tropics, and our problem is further complicated by the fact that you cannot rest on your oars after you have

planted out your young trees, and just wait for them to reach the bearing stage. A very few months of such *laisser-faire* will result in the young trees being overgrown by rampant weeds, and ere long by secondary jungle, which springs up with amazing rapidity in that fertile climate. The weeding and upkeep of a rubber estate is thus a constantly recurring expense which only loses serious proportions when the trees are fully mature and densely shade the ground. Neglect of proper upkeep brings costly punishment promptly in its wake.

In addition to this aspect of the matter, the labour question is of primary importance. The bulk of the rubber plantations have been developed in districts which were sparsely populated, and the coolies necessary for clearing, planting, and upkeep have had to be recruited in the case of Ceylon and Malaya from India, and in the case of Sumatra from Java. This recruitment of the coolies, their transportation several days' journey oversea, their housing and medical treatment, all involve a considerable outlay of money, whilst in the case of the East Coast of Sumatra a three-years' contract on mutual terms is entered into between the plantation owner and the labourer he recruits. In Malaya there is a certain amount of " casual " labour in the shape of Chinese, and in Java and Southern India the coolies' work is not far distant from their homes; but in the main it is true to say that the building up of a satisfactory estate labour force is a costly process, and the plantation rubber industry could not exist if it attempted to work with " casual " labour on a fluctuating basis. In point of fact, the estates which have most difficulty in satisfying their labour requirements are those who depend on the natives of their own district, the counter-attraction of work in the rice fields being the cause of a shortage of estate coolies at the time when they are most needed.

Thus far we have briefly touched on two matters of primary importance to estate proprietors :—

(1) The necessity of regular upkeep week by week to preserve their principal asset, the growing trees.

(2) The maintenance of an efficient labour force.

Before entering upon a detailed examination of the conditions in the plantation rubber industry since the world slump in 1920, I would like to make one reference to the question of adjustment of supply and demand as it affects the manufacturers and consumers of rubber goods, in which tyres are of course included.

Except for a short period in 1910, when there was a shortage of supply in relation to demand, on the strength of which the price of rubber was forced, largely by speculation, to a fantastic figure, there has been an increasing supply of rubber to satisfy an increasing demand, the weight of supply being slightly in excess of the demand, with a marked diminution in price, rendered possible by the reduced cost of producing larger crops as a greater proportion of the rubber trees attained maturity. There were occasional fluctuations in price owing to the seasonal character of the demand, but, except during the boom of 1910, no question of shortage in supply has troubled manufacturers or consumers, the

difficulties which had to be contended with at the acutest stage of the war being due to the want of shipping facilities and not to a shortage of rubber in the world. The declining tendency of rubber prices, however, presented one very real problem to the manufacturers, because prudence requires them to carry several months' supply of raw material for their large-scale operations, and they were repeatedly in the predicament of having to write large sums off inventories solely on account of the decline in the value of rubber. This was very disconcerting, and it was not unusual to hear manufacturers earnestly appeal for some sort of stabilisation of price which would enable them to push ahead the development of their business without having to worry about depreciation of this nature. Consumers had no such problem, as competition for their custom resulted in their regularly getting the full benefit of lower rubber prices. It required a crisis of the first magnitude to bring into being a scheme having for its declared object the approximate adjustment of the supply of rubber to the demand, and I will now deal with that in greater detail.

Already in 1913 the question of possible over-supply of plantation rubber was envisaged by some of the leaders of the industry, and it was then recognised that the most practical step to take was to encourage the development of new uses for rubber. The extraordinary growth of motor transport which developed directly and indirectly as a result of the war, postponed for some years the advent of an actual over-supply of rubber. At the end of 1917, however, the shortage of tonnage necessitated a reduction in the consumption of all sea-borne commodities to a minimum, with the result that producers of rubber were accumulating substantial stocks in the East, which could not be transported to the countries of consumption. The Council of the Rubber Growers' Association thereupon propounded the first scheme for co-ordinated action, designed to bring about an adjustment between supply and the then restricted demand for rubber, which in all Allied countries was controlled, for military purposes, by Government. The price of rubber in London in August, 1918, was 2s. per lb., whereas in the Eastern markets the price had declined to the then record low figure of under 1s. per lb. at the same date.

The scheme was a very simple one—namely, a voluntary agreement to reduce the production of rubber for the year 1918 to 80 per cent. of each producer's output for 1917 or for any previous year showing a greater yield, with a minimum during 1918 of 200 lb. per acre in bearing. Approximately 75 per cent. of the acreage owned by members of the Rubber Growers' Association in London agreed in writing to this proposal, which was scrupulously adhered to by them but, in contrast to this co-operative action on voluntary lines, a large proportion of the local producers in Malaya and Ceylon, and of producers in the Dutch East Indies outside the membership of the Rubber Growers' Association, not only declined to make any move for the common good, but in many cases increased their production. Nevertheless, the restriction actually practised was a means of keeping about 35,000 tons of rubber off the market. In the middle of 1918 negotiations were opened by the Association with Government with a

view to the establishment of a definite legislative scheme for compulsorily regulating the production of plantation rubber, coupled with the fixing of prices at a level which would enable the industry to carry on. The matter was under consideration for some time, until the Armistice brought about a complete change in the situation. The post-war boom followed, and it was not until the subsequent slump in 1920 that difficulties again appeared on the horizon, accentuated in the case of rubber by the development and increasing use of the " cord " tyre, which was found capable of a much greater mileage than the earlier fabric tyres. The Council of the Rubber Growers' Association on September 24th, 1920, issued a circular to all producers of plantation rubber, in which they drew attention to the rapid decline in price to a figure very near the average cost of production; that a careful study of the then tendency of trade foreshadowed an actual over-production of 35,000 to 40,000 tons of rubber at the end of 1920; and that, unless world conditions materially altered for the better, the unwanted surplus would be further augmented during 1921. It was pointed out that if the production of plantation rubber were in a few hands it would be a simple matter to adjust supplies to suit any alteration in the demand, but the diversity of nationalities and races offered almost insuperable difficulties to any effective voluntary organisation. Absorption was abruptly curtailed, and during 1920 world stocks of rubber had increased by about 60,000 tons. The Rubber Growers' Association's second restriction scheme came into operation on the 1st November, 1920. It took the form of a voluntary reduction of each producer's output to 75 per cent. of the estimated normal monthly output. Assents were to be dependent on 70 per cent. of the producing area represented by members of the R.G.A. similarly agreeing, and the need for this co-operative action was so widely appreciated that over 95 per cent. of the Association's European membership agreed to be bound. The International Association at The Hague secured the assent of over 70 per cent. of its members, the Ceylon local proprietors supported the scheme, and a large proportion of the members of the Rubber Producers' Association of Malaya and of the Japanese Planters' Association of Malaya came into line. The effect of the scheme, combined with the steadily falling price of rubber, was to reduce the output of plantation rubber for 1921 by over 25 per cent. Nevertheless the stocks of crude rubber increased by a further 20,000 tons during that year.

The increase of 60,000 tons in the stocks of crude rubber at the end of 1920 did not represent the total existing surplus of rubber, for the world rate of absorption had fallen from 30,000 tons per month to 20,000 tons per month, and, as the world's necessary stocks are equivalent to eight months' absorption, only 160,000 tons were then necessary for the normal working of the industry, thus indicating a further surplus of 80,000 tons, or a total surplus of 140,000 tons.

Early in 1921 the planters in Malaya requested the Government to control output; but this was refused, on the ground that the industry should work out its own salvation.

Throughout that year various schemes were considered, the most important being that of the Rubber Growers' Association to form a Producers' Corporation to regulate output and control price. None of these schemes succeeded in obtaining the necessary support, and a short-lived rise in price at the end of the year to 1s. per lb. was responsible for preventing the renewal of the restriction scheme which had been in force during 1921. Thereafter each producer settled his own output policy; many continued to restrict their output, but financial necessity compelled a large number to produce to the utmost of their capacity. More rubber was again being produced than the world could absorb, and the price fell to a new low level of 6¾d. per lb. in August, 1922.

It soon became obvious that the industry was incapable of working out its own salvation, and that in a large number of cases the producers seemed determined to encompass their own destruction. The situation in Malaya, where, with the exception of tin, rubber is the only important industry, was becoming increasingly serious. Revenues were dwindling; large numbers of trained coolies were returning to India; native holders were faced with ruin, and many of them had already abandoned their holdings. At the end of 1921 the British Government appointed a committee, afterwards known as the Stevenson Committee, to consider the situation. The committee reported to the Colonial Secretary about the end of November, and recommended a scheme to be enforced uniformly and simultaneously in Malaya, Ceylon, and the Netherlands East Indies. The Dutch were approached in the matter, but it was not until August, 1922, that they definitely refused to co-operate. The Stevenson Committee were again called together, and in their supplementary report, issued in October, they recommended the adoption of the scheme in Malaya and Ceylon only. Their recommendations were adopted by the Colonial Secretary, and were brought into operation on the 1st November, 1922.

The committee have been accused of inconsistency, because in their first report they postulated the impossibility of any action without the co-operation of the Dutch Government, while in their supplementary report they advised that their scheme could be operated effectively without the co-operation of the Dutch, provided the British estates in the Netherlands East Indies adopted it voluntarily. It must be borne in mind, however, that between November, 1921, and October, 1922, a considerable improvement had come about in the tyre and rubber goods manufacturing industry. At the end of 1921 practically all the important manufacturers estimated the world absorption of crude rubber for 1922 at significantly less than 300,000 tons—the figure adopted by the committee—but by the middle of 1922 these estimates were proved to be too low, and justified the adoption of the original scheme in Malaya and Ceylon, supported by the voluntary co-operation of the British estates in the Netherlands East Indies and elsewhere, despite the possibility of the rest of the producing areas continuing on full production. The details of the scheme and the legislation based on it are so well known that I need not detail them here, but it may be interesting to summarise the results of the first

fifteen months' working. When the scheme came into force on the 1st November, 1922, the total world's stocks of rubber were about 330,000 tons, the highest ever accumulated in the history of the industry. There were about 20,000 tons of rubber in Singapore and Penang over and above the stocks normally in those ports. In addition to these some 7,500 tons of dealers' and smallholders' stocks on the mainland of Malaya were licensed for export, whilst in Ceylon all stocks, whether in the hands of producers or dealers, amounting to nearly 11,000 tons, were similarly licensed. These facts are invariably overlooked when people compare the figures of exports from Malaya and Ceylon since the Restriction Scheme came into force with what the scheme purported to do. It was never intended to impose on merchants' and dealers' stocks in hand at October 31st, 1922, the export restrictions, which were to apply only to producers.

Notwithstanding the fact that these accumulated stocks had to be dealt with, in addition to the new production licensed for export under the scheme, by the end of January, 1924, the stocks in Singapore, Penang, and Colombo had been reduced to normal working quantities, and the stocks in London and Liverpool had been reduced by 13,000 tons; thus a total reduction of 40,000 tons in the world's free stocks had been effected in the first 15 months of the scheme, notwithstanding the fact that the exports from the Netherlands East Indies were increased by over 30,000 tons, consisting largely of native rubber with a high percentage of moisture, but equivalent in dry weight to between 20,000 and 25,000 tons. Had the Netherlands East Indies Government co-operated with the Governments of Malaya and Ceylon the position would have been proportionately strengthened.

The total acreage under cultivation with plantation rubber is approximately 4 million acres, distributed over the countries tabulated in the following percentages :—

Ceylon	10%
Malaya	55%
*Netherlands East Indies	27½%
India	3%
British N. Borneo and Sarawak... ...	2¼%
French Indo-China...	1¾%
Other Countries	½%
	100%

Thus 78% of the planted area is either under the British flag or in British ownership.

Three-quarters of the industry are working for the permanent well-being, not only of themselves, but of the consumers, and one-quarter of the industry is taking every advantage without making any contribution to the common cause.

The production which might be harvested during 1924 (including wild rubber) is in the neighbourhood of 500,000 tons if everyone were on maximum output, and there will be in due course

* 30% of the planted area in the Netherlands East Indies is in British ownership, equivalent to 8% of the grand total.

a further increase in the potential production when the present planted area is fully mature. World absorption for 1924 will be in the neighbourhood of 430,000 tons.

The scheme has introduced confidence not only within the ranks of producers, but amongst the manufacturers. The pivotal price was fixed at the lowest figure which would give a moderate profit to producers generally, whilst affording every encouragement to manufacturers and consumers to further increase the consumption of rubber, which plays such an important part in the life of the world to-day. The consumption of rubber has been, with minor fluctuations, expanding at a phenomenal rate. The properties which rubber possesses are unique, and are a boon to mankind. Is it not therefore in the best interests of the world at large that the sources of the supply of rubber should be preserved in good condition, so that they may in the years to come yield the latex necessary to satisfy the world's expanding need of rubber?

If this carefully designed legislation had not been introduced in the autumn of 1922 what would have happened? In August of that year, before the prospect of remedial legislation took definite shape, the price of first-grade rubber delivered on the London market was 6¾d. per lb., a price at which no producer could cover his actual cost (though a few deceived themselves into thinking that they were not losing money because they overlooked the fact that necessary estate works were being inadequately attended to). Such a surplus stock of rubber existed that even at 6¾d. per lb. nobody had the confidence to buy except for actual needs. Estate proprietors, after 18 months of struggle with adversity, were nearing the end of their financial tether; native holdings were being abandoned; labour was losing employment, as were also many European employees, and the industry was in the throes of a bitter struggle for survival, in which not necessarily the owners of the fittest estates, but those with the longest purses would be the survivors. An industry of this magnitude and importance could not drift into chaos without results disastrous not only to the owners of the estates, but to the community at large. The organisation necessary for its efficient working had been built up laboriously over many years, and once broken up the lapse of only a few months would have rendered its rehabilitation both difficult and costly. In the meantime, the regular flow of rubber to the market would have been reduced, and the point would in due course have arrived when the speculator, ever on the outlook for something out of which to take an " unearned " profit, would have seen to it that the price of the available rubber was raised against those who needed it. As the price improved the effort to recondition derelict estates would commence, most probably with capital other than that of previous owners; there would be a feverish scramble for labour such as there was in the false boom of 1919; the cost of production would then be considerably higher than it has been under the Restriction Scheme (which has enabled the industry to retain its essential organisation in efficient shape), and by degrees no doubt the area planted under rubber would, for the most part, have been got back into production. The world as a whole, and in particular the nations who have built up this

great industry, would, however, have been heavy losers. It means a lot to the Dutch, not only to the capitalists in Holland, but to the natives of the East Indian Islands, which are under the guardianship of the Dutch Government. I find it difficult to believe that the interview recently given by the Director of Agriculture of the Netherlands East Indies to a local newspaper (which has not been repudiated) is representative of the sense of responsibility of the Ned. Indies Government. The Dutch thoroughly understand the benefit of combined action in cinchona, of which they have a virtual monopoly, in Deli tobacco, and in sugar. The arrangements which exist in these important industries will be well known to most of you, though they are not published to the world in the open way in which the Regulation of Rubber Exports has been advisedly done. The latter scheme is not a one-sided arrangement, but is framed in the interests of all those to whom rubber means anything. It has stood the test of searching criticism from all quarters, and has not been found wanting in any of the elements which are essential to the fulfilment of the high purpose with which it was conceived. Continued in that spirit, assuredly it will not fail.

DISCUSSION.

The CHAIRMAN: On behalf of the members of this Conference I must tender our hearty thanks to Mr. Miller for the trouble he has taken in providing us with this paper, and an expression of our sense of gratitude to him for the exhaustive way in which he has traced the history of this modern attempt at fitting production to consumption without allowing the blind laws of natural economies to work. As one would have expected, he has taken us through the past history, and having drawn an eloquent picture of conditions as they existed two years ago he has then had to rely largely upon your sense of imagination in asking you to picture what would have been the conditions now had action not been taken when it was.

It is very difficult for those of you who have not been through the crisis—for the public and the manufacturers—entirely to visualise what the future of the plantations would have been had that future not been safeguarded by this restriction scheme, a scheme which we producers claim has been put forward as much in the interests of the public and manufacturers as in the interests of the producers. It is difficult, as Mr. Miller said, to speak with moderation and calmness of the action of those producers who have refused to bear any share of the burden of restriction, but who have at the same time taken all the benefits which have accrued from it. I should welcome from members of this Conference any exposition of their point of view which might justify such action, if such point of view can be put forward and such justification can be made public. I hope that side of the question may be put to this meeting. It is well not to have simply one side put to a meeting and discussed. With these few words I commend to you for open discussion the points that have been raised by the paper.

Mr. QUINCEY TUCKER: I come from America, and I want to say I am very much in favour of restriction, and I would like

some information as to why the Dutch do not come in. Have they given any definite reason why they have stood out?

Mr. MILLER: We have our friend Mr. Sanders, who is on the Council of the International Association for Rubber Cultivation in the Netherlands Indies at The Hague, here this afternoon. I am sure he can give you some of the reasons that are put forward by the Dutch for excusing themselves from any co-operation.

Mr. M. SANDERS: I am in rather a queer position. But you know I have always been on your side on this question, and I have been one of the few Dutch members of the International Association who have fought for your point. I am as convinced as you are that the way of restriction you put forward is the right way to go, but the greater part of the Dutch members of the Board have been of a different opinion, and their way of looking on the business, as far as I can appreciate it, is in the first instance that they are so much opposed to every form of Government interference that they will not come into it. This applies to all Government interference. We have come to the conclusion at The Hague that Government interference has in the latter years been mostly to our detriment, so we are much opposed to it. There are quite a lot of our members who would not look so unfavourably on the Stevenson Scheme if it were not necessary to have Government interference to enforce it. You know very well, and you, Mr. Miller, have shown in your exposé, that there is no oppression of the planters in the scheme. The objection to Government interference is, I consider, the most important cause of my countrymen having stood out.

For my part, I would have accepted the Government's interference, because I found it, just as you did, a matter of the first importance to have a curtailment of production so as to adjust it to consumption.

The second cause, I think, is that we in the Netherlands Indies are not looking at it from such a broad point of view as you are. We are looking on it too much as planters, and are not sufficiently acquainted with the manufacturing side of the business. I had an opportunity to go to America, and visited quite a number of factories, and I am quite convinced that what is to our profit is also to the advantage of the manufacturers. But that is a point of view most of my countrymen do not take. They mostly consider that there are two parties in this case, the planting and the manufacturing party, and as far as I can see they are not quite sufficiently acquainted with the fact that both parties are equally interested in the adjustment of production to consumption. As you told us in your paper, it is to the greatest advantage of the manufacturer that he should be quite certain, not only for present times, but also for the future, that he will be able to have a sufficient supply of raw material at his disposal; and if by lack of organisation in the planting industry the position of this industry will be endangered in the future it is very certain that this will be to the serious harm also of the manufacturer.

These are, as far as I can see, the reasons why so few of my friends are on your side on this question. Mr. Miller has been at

the meetings in Holland, and knows very well what my point of view always has been.

For my part, I am certain that most of my countrymen are honestly convinced that they must not accept Government interference. There are always quite a lot of men who look on this business in the simple economic way of supply and demand—the old theory of the survival of the fittest. I for my part am quite convinced that in a few years they will find out that they have been wrong.

Mr. Quincey Tucker: Has the International Association at The Hague taken any official action in this matter of restriction? Did they take any action or did they simply do nothing? I understood that Dr. Swart has many interests with the British.

Mr. Sanders: Not so much with the English, but with French and Belgians. Part of the members of the Association are English members, and those are all in favour of the Stevenson Scheme, as are a number of the Dutch members. The Board of the International Association addressed itself to the Minister of Colonies asking him to nominate a Committee to work with the Stevenson Committee with a view to coming to a solution acceptable to both parties, but as soon as the Minister found that, though a majority of the Association, including the British and others, had approved of restriction, yet the greater part of the Dutch members were much opposed to it, he was not anxious to do anything to nominate that Committee, and it has never been nominated. The Board of our International Association gave the names of the men they wished to have on the Committee. I am quite convinced that a majority of my countrymen hate very much to be in their present position, but still that does not bring them over to the Stevenson Scheme as long as Government interference is necessary.

Mr. Noel Bingley: Mr. Miller has referred to the Cinchona combine which the Dutch themselves brought into existence, but, of course, this is quite a different proposition, as something like 90 per cent. of the quinine of the world is produced from Java. And the same applies to the Deli Tobacco combine and the Sugar Trust in Java—both industries are comparatively in only a few hands. But it may be some consolation to some of us who have been working hard for many years to try and get the Dutch into this Rubber Restriction Scheme if we remember that it took thirteen years to bring the Dutch Cinchona Growers into that combine. I started cinchona planting in 1892, and from then onwards for some years prices were on the downward grade until they reached about 3 cents the unit, at which only the cheapest producers could show a very small profit, and for some years, if I remember right, the unit price hung round about that figure. We producers were entirely in the hands of the manufacturers, who were mostly German, but certain owners of Dutch plantations had the same idea then in their minds that I believe to be at the back of their non-participation in the present Restriction Scheme, namely, that the survival of the fittest is the best, if not only the

eventual solution of difficulties like these existing in the Rubber Industry to-day. Only in 1913 did we succeed in overcoming the objections of the last of these " diehards " when the combine of Producers and Manufacturers came into existence and brought about a complete transformation in the position of the Growers, which has been one of comparative prosperity ever since. I confess to being still an optimist as regards getting the Dutch into some form of restriction scheme, especially if it can be combined with Co-operative Selling. I believe every year more of the Dutch Producers are beginning to see in which direction their interests lie. I was the first member of the Council to go over for the Rubber Growers' Association in 1921 to discuss Voluntary Restriction with our Council of the International Association at The Hague when with one, possibly two, exceptions, they were unanimously opposed to participating in any definite scheme for Restriction of Output, though many of the members expressed sympathy with the idea of a selling combine, if a practical scheme could be organised, and I do not despair of it being possible to find some basis of mutual co-operation between British and Dutch Rubber Producers before very long. In Java itself, amongst the planters, the desire for co-operation in some form or other with the neighbouring British Colonies is, if my information is correct, steadily gaining ground.

I am very much in the same position as Mr. Sanders here as a member of the International Association, and as there are so few of the Dutch spokesmen here to speak for themselves, I feel it is up to any of us, who are closely associated with Dutch planting interests, to express their point of view as far as possible. There is still another reason for their attitude, and that is in regard to the rapid increase of native-owned rubber in their colonies, especially in parts of Sumatra, as one cannot ignore the difficulties of the introduction of any restriction scheme which does not deal also with native rubber. The land in those parts of Sumatra, where most of the rubber is grown, actually belongs to the natives, and I understand it would really require an alteration of the existing laws to prevent the natives producing all they want to produce, so that supposing the majority of the European owners were in favour of restriction and could get the Government to share their views on these matters, they might still be up against this difficulty of how to deal with the native growers.

Mr. MILLER: In reference to the last point, there is nothing on earth to prevent any Dutchman from voluntarily doing anything which the English are doing by legislative action.

Mr. JAMES FAIRBAIRN: I think we must all thank Mr. Miller and must all sympathise with Mr. Sanders. Mr. Miller has just voiced what I was going to say, that it is open to the Dutch producers to join voluntarily. But so far from doing that, they have not only not done so but have gone to the length of making forward contracts as far as they can, and have thus gone as far as they possibly could to defeat the Stevenson Scheme. Every man is entitled to do what he likes, and I sympathise with the Dutch in their desire for freedom from Government interference.

I am very pleased to hear Mr. Bingley speak hopefully, as one who knows Dutchmen. I know the Dutchman, having lived with him in South Africa for years, and I hope he will become reasonable and will see that we, the senior partners in the rubber industry, are entitled to fair treatment, which we are not getting at present from him.

Mr. Cyril Baxendale: Speaking for the Planters' Association of Malaya, whom I represent, as well as myself, I would like to say how much the action of the Stevenson Committee is appreciated there. I was this time last year in Kuala Lumpur, and took the opportunity of getting native as well as European opinion, and on every hand I found an enormous improvement in the spirits of the whole of the people, both native and European, and the strongest expression of admiration for the Stevenson Committee, and particularly for the work of Mr. Miller himself. The contrast with 1921, when I was there before, was wonderful and very heartening. In passing, I should like as a planter to tell you I was enormously impressed with the magnificent work that was being done in giving effect to the restriction regulations by the Government of the Malay States, and particularly by the Chief Secretary, Sir George Maxwell, whose work, I think, was that of a genius.

Mr. Fordyce Jones: May I ask Mr. Miller a question? I am, of course, well aware of the work he has done with reference to restriction, and I much appreciate his wonderful paper. But I would like to point out that adjustment does not end with the work of the Stevenson Committee, but it goes further, and that is in propaganda, and I would ask Mr. Miller to use his abilities at this end of the problem—that is, in the adjustment of the price of the manufactured article to a reasonable figure. I believe that in a solution on these lines there is a great opportunity for increased consumption. Henry Ford says that while 80 per cent. of the people can buy Ford cars, only 20 per cent. can buy *de luxe* cars. A great many people can buy our old friend the hot water bottle at 4s. 6d., and only a very few will buy one if it is 7s. 6d. I think we should get the best brains together in our industry and get good but low-priced articles put before the public so as to widen the market and in that way help to solve the problem of over-production.

Mr. Miller: I very gladly promise my support on these lines, because the poor old public do not get value except in the matter of tyres. In this paper I have had to confine myself to the subject at the head of it. The Rubber Growers' Association are taking a very broad view of propaganda. I added when the Stevenson report came out that my own opinion was that any surplus funds should be made available for the use of the industry. I have not abandoned that view, and I think a vast sum of money must be available in the East which should be made use of to encourage every legitimate expansion in the use of rubber.

Mr. Baxendale: One point I was not quite clear about. Did I understand you to say that goods had had to be written down

on account of the fall in the price of rubber? I thought the price of rubber did not materially affect the value of stock.

Mr. MILLER: The manufacturer carries in the ordinary way three, four, or five months' supply of raw rubber.

Mr. BAXENDALE: You referred to raw rubber?

Mr. MILLER: The profits made by manufacturers in America were very seriously reduced because of the writing down, not only of manufactured goods, but of the crude rubber in stock.

The CHAIRMAN: If there are no further questions, I think, though Mr. Miller has dealt with most of the questions as he went along, he might now like to deal as a whole with the questions that have been put to him. One must not forget that in his paper he was dealing only with the adjustment of production and demand.

Mr. MILLER: My reply is merely to thank you all for the patience with which you have listened to me. This has been a hobby with me for some time.

THE RUBBER INDUSTRY—A PLEA FOR CLOSER WORKING.

By JAMES FAIRBAIRN.

Mr. P. J. BURGESS, who presided, said: It is my pleasant duty this afternoon to introduce to you Mr. James Fairbairn, who is going to read a paper on "The Rubber Industry—A Plea for Closer Working." Mr. Fairbairn is known to all of you as a very considerable administrator of plantations in the East, and this is a subject which I know is very dear to his heart. We shall all be very interested to hear what he has to say on the subject.

Mr. JAMES FAIRBAIRN:

Mr. President and Gentlemen,—I welcome the honour that has been paid to me in being invited to read a paper before you in this City of Brussels on the occasion of the Sixth International Rubber Exhibition—the first to be held here since the Great War. Although in that ever-to-be-deplored conflict the Belgian nation suffered untold hardships, your beautiful city—unlike so much of your country—was happily spared from serious material damage, but we shall never forget that Belgian and British then fought side by side, and I rejoice with you that your minds and ours are now free to discuss, for our mutual benefit, matters connected wholly with industry and peace.

In view of the manifold advantages that are to be gained by means of mutual co-operation among all who have interests in common to protect, it is an astonishing fact that, as far as the producing side of the rubber industry is concerned, there is still so little co-operation in matters that concern the interests of the industry as a whole.

Because of this lack of co-operation, I have chosen for the subject of my address "The Rubber Industry—a Plea for Closer Working." I believe that if the rubber industry is to be well served those who are responsible for its control must work more closely together year by year. Especially does this apply to the British and Dutch producing interests.

The two nations in the character of their peoples, in their national institutions and traditions, as well as in their success as tropical agriculturists, have much in common, and the friendship that has long existed between them has been further cemented by the close connection into which the two nations have been brought by their mutual interests in the plantation rubber industry.

Speaking as a Scotsman, I feel that, great as is the similarity between the character of the English and the Dutch, there is an

even stronger resemblance between the Dutch and the Scotch—for are not we Scots, like the Dutch, reputed throughout the world for our sagacity and our caution? John Bull, on the other hand—well, gentlemen, perhaps you will pardon me if on that delicate subject I say no more. Let us be content to agree that the British and the Dutch, as well as the Belgians and the French, have staked a vast amount of capital and an enormous amount of labour in creating the great industry of which we are all so justly proud, and upon which every civilised country in the world depends for its rubber.

Yet we have to admit, I think, that much of the fruit that rightfully belongs to us as the natural reward of our labour and of our capital is forfeited because of the lack of cohesion we exhibit—particularly when, as producers and sellers, we find ourselves matched against the keenness, the efficiency, and the admirable spirit of mutual helpfulness that prevail among those who, as buyers and consumers of the bulk of the commodity we produce, control the great rubber manufacturing industry of the United States.

Let us, then, examine the industry as a whole, and see if we can suggest to the various branches a constructive scheme of mutual co-operation and help in this, one of the great world industries.

I will endeavour to deal with the subject in its logical sequence.

Firstly, dealing with the producing side, the total area cultivated with rubber in the East is spread over the different countries roughly as follows :—

British	72%
Dutch	25%
Other Countries	3%

As regards British production, you are all aware that we have a compulsory scheme regulating by law the export of rubber from British Malaya and Ceylon, while in Southern India, Burma, and British Borneo the scheme is merely voluntary. Now, it seems to me to be quite illogical that while Malaya and Ceylon, the major producers, are bound by a legislative scheme, the production of rubber in other parts of the British Empire should be on a voluntary basis. This arrangement, for instance, permits certain countries, such as British Borneo, while accepting a measure of restriction, to fall short of the full Stevenson scheme, and if you tell me that British producers should first put their own house in order before seeking the adherence of others, and I can only reply that I fully agree.

Plain speaking on this subject is necessary, and I do not hesitate to admit that in order to harmonise the position of British planting interests the Stevenson scheme should be made legislative in those portions of the British Empire to which it does not at present apply. Having made that admission, I hope you will allow me to say with equal frankness that the policy of the Dutch planting interests, as represented largely by the financial groups in Holland, strikes the average Britisher as being one of complete selfishness—taking all and giving nothing. I feel very strongly

regarding the attitude of the Dutch financiers in Holland who ruthlessly take every advantage of the price improvement resulting from the self-sacrifice of British planters, and who repay our legislative and voluntary measures of crop restriction by permitting the trees on the estates they control to be tapped to the fullest possible extent and as much rubber got out of them as possible. Not content with this wanton disloyalty to the industry to which they belong, they have also made as long forward contracts as possible, so as to ensure the financial stability of their individual estates, regardless of the consequences to those who **have made the price of rubber what it is to-day.**

Without consideration for their senior partners—the British—these Dutch financiers have shown neither consideration for those who have made it possible for them to make these handsome profits nor regard for the real good of the estates they control, and you must forgive me if, in the circumstances, I speak with **some warmth.**

It is a lamentable state of affairs that these Dutch financiers, who claim to be acute business people, should treat their British *confrères*, to whom they directly owe so much, in this cavalier manner by doing all they can to prevent the British planters from **reaping the fair fruits of their labour.**

I trust that Dutch shareholders will go to the meetings of their companies and insist that their directors shall immediately reverse the policy of bleeding their estates, and give up their policy of selfish profiteering. I appeal to them to insist that their directors shall come into line with the people who have helped the industry to its present substantial position—that is, the British **interests.**

The French ownership, in comparison with that of the Dutch, is almost negligible, but, from conversations I have had with leading financiers in Paris who are responsible for production, I have no doubt that the French would willingly come into any scheme for mutual co-operation. They, with our good friends the Belgians, were our allies in the war, and it should not, I think, be difficult to ensure that we remain allies for our mutual protection where our business interests are concerned.

Moreover, those interests, I firmly believe, are not in any real sense opposed to those of the American buyers. The Americans, in order to keep their great industries going, desire to make sure not only of obtaining their present requirements at reasonable prices, but also to ensure that a sufficient output shall be forthcoming to meet the future demand. I may remind you that in the negotiations that took place in January of last year between the delegates from the Rubber Growers' Association to the Rubber Association of America the most cordial relations existed, and I am sure that any reasonable scheme put forward by the growers for the purpose of securing a fair working profit would meet with the approval of our American friends, provided, of course, that they were adequately safeguarded

against such a scheme being used to force up prices to an artificial and unjustifiable level.

The foregoing may be taken as a brief outline of the position of the planting side of the rubber industry as it stands to-day, and of the attitude of the principal consumer. On the planting side we are in the position of having :—

(*a*) A legislative scheme in Ceylon and Malaya,

(*b*) A voluntary scheme in other parts of the British Empire, and

(*c*) The Dutch producing all they possibly can,

with the result that, instead of getting a fair price for our produce and a fair return on the capital invested, the price of rubber is to-day round about 1s. per lb.

It is indeed a deplorable state of affairs that such should be the position of the producing side of the industry. We possess an industry that, if uncontrolled, is subject to fluctuation so severe as at times to threaten our very existence, and yet we find so much lack of cohesion and co-operation that we fail to obtain a fair price for our product and a fair return on the capital we have invested.

I am sure that all planters, whether British, Dutch, or of other nations, must desire to see a better method of selling the raw product than at present exists.

In our present unorganised condition there are many sellers and few buyers, and it is obvious that while such a state of affairs exists we cannot expect to get a fair and proper price for our commodity. I therefore earnestly press that all in the planting industry should combine so as to meet the buyers on their own ground—that is, by getting the selling as far as possible into few hands, so that we can deal with the very few buyers in the market.

Of the amount of rubber we produce, 75 to 80 per cent. goes to America, and we cannot blame the buyers if they desire to purchase their requirements at as low a figure as possible. Our desire should be equally to get the best price for our commodity, and I trust that at no very distant date complete combination of all producing interests for the purpose of selling our product will be an accomplished fact.

In the first instance, I suggest that each country responsible for large production should make a combination, which in its turn should work as an international organisation for the selling of our raw commodity. It is not in the real interests of the rubber manufacturers to press down the cost of the raw material to too low a figure, for with a low price for rubber prevailing for any considerable length of time a large acreage would certainly

be put out of production, and thus sooner or later the time would arrive that no manufacturer wants when a shortage of the raw commodity would result.

The manufacturing side of the industry may be grouped into three important groups :—

1. The American manufacturers,
2. The British manufacturers, and
3. The Continental manufacturers.

The American manufacturers purchase between 75 and 80 per cent. of the total production of raw rubber, the British and Continental groups taking the balance.

The American manufacturer is very highly organised, but the same cannot be said for the British manufacturer.

The British manufacturers are drawing much closer together through the influence of the India Rubber Manufacturers' Association, and I also think a good deal has been done in this direction by the younger society called the Institution of Rubber Industry. I am quite sure, speaking from the planting side of the industry, that the Institution of Rubber Industry has undoubtedly brought the planters and manufacturers into closer contact, and I think I am safe in saying we have a better understanding of each other's point of view to-day than we have ever had before.

It may be worth mention, too, that America presents for the rubber producer a field for the sale of his raw product quite outside the American rubber manufacturer, that is in the sale of crepe rubber for soleing boots and shoes, and here the producer can appeal to an entirely new class of manufacturers—viz., the boot and shoe trade.

We must not forget that only within the last few days Mr. Hoover, the United States Secretary of Commerce, has put forward a proposal that Congress should permit the extension of the Webb-Pomerene Act to allow the formation of agencies for the purchasing in common of certain imported raw materials at present alleged to be controlled by foreign monopolists, and in this letter Mr. Hoover especially refers to the Rubber Restriction Scheme.

I submit that if such a combination should be allowed to come into existence by America the only possible course open to the European producing industry will be to combine, and the European manufacturing industry must also combine for the purpose of meeting unfair competition. Were such a combination allowed to exist without combination in Europe our very existence would be threatened. It would mean that a large portion of the producing industry would have to go out of business, and the result to the European manufacturers would be equally disastrous, as many of them would be forced out of business. There is no doubt that if effective combination of the producers can be carried through, and effective combination of the European manufacturers can also be carried through, and, with a combination of the American manufacturers, all three sections can sit down round a

table and come to a fair and reasonable business arrangement which should be satisfactory to all parties.

The position, gentlemen, is in our hands.

The whole attitude of Britain in these post-war times, in my opinion, is too quixotic. Our American friends would be the first to admit that we have settled our debt to them—as I need not remind this audience, a debt that was incurred in the interests of the peace of the world—and we arranged that settlement without so much as suggesting that it was time to ask for payment by certain of the American States of the debts due to Great Britain, which amount to-day to a very large sum.

Again I have to ask your indulgence for my plain speaking, but you will, I think, agree with me that Britain is ever ready to assist other countries, and I ask you whether it is quite fair—is it, to use our national phrase, quite playing the game—for those who call themselves England's friends to leave her in peace and in war to shoulder the burdens of the world?

I am afraid that with the time at my disposal I have not been able to develop my subject so fully as I would have liked; but, in closing, may I point out to the manufacturers the enterprise shown by the Rubber Growers' Association in founding and carrying on the Propaganda Department of that Association. We have pioneered a number of new uses, including rubber roadways, the introduction of latex into paper-making, and—probably most important of all—the pushing of the crepe rubber sole prominently before the public. This last material should demonstrate to the manufacturers the enterprise and wishfulness on the part of the planting industry to do its utmost to find new uses for rubber.

That new uses can be found and can be developed goes without saying; but it is only by close combination and close co-operation, and much closer working together than we have been in the habit of doing in the past that great results can be achieved.

DISCUSSION.

The Chairman: The applause with which you have received this paper shows how deeply you have been interested in it. If I might take it that the applause signified the entire acquiescence of all the audience in everything he has said, then he must have been pushing an open door, and I am afraid there will be nobody here to put the opposite side before us. In his paper he does what many others have done—he has put the question of restriction as it appears to the British producers and as it concerns Continental producers very clearly before us; and I think it is a very significant thing that so many papers have dealt in a similar way with this burning question. It is evidence of the depth of the feeling with which this subject is regarded among British producers that these gentlemen, who have written their papers without any collaboration, have not been able to write

without bringing in, like " King Charles's Head," the question of British restriction *versus* free production by the Dutch.

Mr. Fairbairn also brings forward a proposal for dealing in a very comprehensive way with our sales, so that instead of having a number of selling units these should be combined into bigger groups and thereby get greater strength in bargaining when dealing with people buying the rubber for actual absorption into manufacture. He makes one reference to certain debts which are owed by American States to Great Britain. Now, I am quite sure that many of you are as vague as I am as to the details of those debts and the particular facts to which Mr. Fairbairn has just referred, and I should personally like him to go into further detail there and give us some chapter and verse for this suggestion that there are very considerable debts outstanding from American States to British creditors. I have no doubt he will be able to explain the allusion, which was contained in quite a few lines of his paper.

He winds up, as is quite natural, with some reference to the other side of the picture, which is this great effort which all interested in rubber production must make, whether their produce is restricted or unrestricted; that is, the effort to make consumption equivalent to demand, and that can only be by finding new uses. Of course, the greatest use is in motor tyres, but the demand for rubber for this purpose is so large, apart from the vast capital employed in it, that it is almost impossible for rubber producers to affect it much one way or the other. As I mentioned the other day, the whole of the omnibuses in London do not consume in one year more than 150 tons of raw rubber, and if you visualise what is the quantity that is consumed by road traffic it will be quite clear that it would be a problem almost bigger than any association could attempt to deal with, so to extend motor traffic, or to bring such influence to bear upon motor traffic, as would materially increase rubber consumption there. It must be other directions to which we must turn our attention. I hope you will let us have your views and will criticise his paper as severely as ever you can. The more severe you are the better he will like it.

Mr. Quincy Tucker: I want to say there are other people who have benefited by British restriction who have been overlooked. For instance, the American reclaimers were very hard-hit when rubber went down, and one of the last things I heard before I came over from an American reclaimer was, " When you go over, get the price of rubber up !" There are the Brazilians too; but for restriction they would have gone out of business altogether. I would like to hear about that American debt that Mr. Fairbairn referred to.

Mr. Fairbairn: I will tell you where you can get some account of these American State debts. It is mentioned in the annual report of the Council of Foreign Bondholders, a Council which exists in London and which deals with all matters of defaulting debts of foreign States. You will find there a list of the defaulting States and the debts owing by them. I exclude the amounts

due to the British from the Southern States during the war. That was a " spec." The position of the States comprising the United States is peculiar. No person can sue a State of the Union, but one State can sue another. Therefore we, as it were, cannot get a judgment and put the broker's man in, but Washington could do it, and I am only sorry that Mr. Baldwin did not ask Washington to put the broker's man in for us.

Mr. TUCKER : It was before the Civil War?

Mr. FAIRBAIRN : Yes, fifty to eighty years ago. The secretary of the Association in London will always give you information.

The CHAIRMAN : Are the debts substantial? Do they run into millions?

Mr. J. G. HAY : I think it is fair to mention that it is not a direct obligation of the Government as a Government but of a State as a State, and probably the American Government takes the attitude that it has no jurisdiction. It is just as if a municipality defaulted in England. It would not be a matter which affected the British Government itself.

The CHAIRMAN : But I think the municipality could be sued by a foreign debtor in an English court of law. This is a case of foreigners being unable to sue, because the State takes advantage of a local law.

Mr. FAIRBAIRN : It is hardly even in line with that. It would be more in line if Scotland, Ireland, or England had had pre-amalgamation debts which Great Britain had refused to honour. That would be the position.

Mr. D. F. L. ZORN : I think there is no great likelihood of a lengthy discussion to-day because the audience are practically in agreement with Mr. Fairbairn in most of the points he has raised. There are just two thoughts I would like to call attention to. One is that to-day the coming of co-operation, of amalgamation, of combination in history—not only in the rubber industry but in all industry—is a stream of tendency which is growing, and which is cumulative. While certain people might object to the very idea of amalgamation or combination or co-operation, in the rubber industry, for instance, they would only in such a case be attempting to swim against the tide. We all know what a perfectly futile thing it is to try to swim against the tide, especially when it is running hard.

The other thought is this, that certain of the observations Mr. Fairbairn has made remind us that in the rubber industry in the course of the last two or three years we have already arrived at a very encouraging measure of co-operative action, a thing which even three years ago many people might have thought was not likely to occur. As we know, the rubber industry in all its sections was only a few years ago remarkably behind the times with regard to anything like co-operative action, whereas I think we may safely say that to-day the rubber industry is getting well up, and attaining a fairly forward position in this matter. Mr. Fairbairn has alluded to the co-operative action for propaganda,

which has certainly met with a striking measure of success, and he has also alluded to the Institution of the Rubber Industry. Now, that is a new movement—it has been in existence less than three years—but it is undeniably a valuable movement. And the good thing is that the Institution deals with the industry as a whole. It has afforded many opportunities for all sections to get together.

I am sure we are all of us in hearty agreement with Mr. Fairbairn on one point at any rate, and that is that the sooner something can be done, as he suggests, which will enable the different sections of the industry to get into complete combination and get properly united in a really effective way, with suitable machinery, so that, for instance, rubber growers can sit down with rubber manufacturers, American and British, and talk business across a table with each other—the sooner that can happen the sooner will our clash of interests die away. I find there is a foolish tendency on both sides to imagine that our business opponents—that is the best term to express what I mean—do not know what cards we have got up our sleeve. That is perfectly futile. Both sides know what cards the other sides have up their sleeves. The best thing is to put all the cards on the table, and I think what Mr. Fairbairn has said this afternoon will do much to help to bring that very sensible process about.

Mr. FAIRBAIRN: I want to make it quite clear that I was not hitting out at the Americans in that matter of the debt. I only said we did not *ask* for it. I do not want to get up a political movement. I am a Britisher, and I want to see my nation's best side. As a Scot I admire the Englishman. I think he is a sportsman in every sense of the word. I say that as a Scot, otherwise there would not be so many of my countrymen in England.

The CHAIRMAN: There is only one thing left to be done, and that is to pass a hearty vote of thanks to Mr. Fairbairn for the paper he has read.

THE DEVELOPMENT OF THE PLANTATION RUBBER INDUSTRY.

By ERIC MACFADYEN, M.P.

Mr. P. J. Burgess, who presided, read Mr. Macfadyen's paper, which was as follows:—

The production of crude rubber from trees occurring naturally in the equatorial regions of the world, notably in the Amazon Valley, has been effected on a commercial scale since the beginning of the 19th century, but the production of rubber from systematically cultivated rubber plantations dates no farther back than the end of last century.

The first rubber trees were sent from Kew to the Ceylon Botanical Gardens in 1876, and from trees planted from the seeds of these nearly 120,000 acres of rubber were planted, mainly in Malaya, Ceylon and the Netherlands East Indies, during the next 30 years; the Singapore Gardens playing the chief part in the distribution of seed.

The experience gained during those years proved that it was possible to cultivate rubber on a large scale in the Eastern tropics and gave some indication of the attendant risks.

In the meantime, the introduction of automobile transport and its prospects of expansion, pointed to a great increase in the demand for rubber for tyres and tubes, without which any real development in such transport was impossible. During 1905, there were 78,000 automobiles registered in the United States, and by the end of 1909 the total number registered had increased to 311,000, or four times the number registered four years previously. A similar, though less rapid, increase occurred in other countries.

Concurrently with this increase in the use of automobiles (which caused a steady increase in the demand for, and consequently in the price of, rubber) increased areas of rubber were planted in the East, and during the years from 1906 to 1909, inclusive, nearly 800,000 acres were planted up.

In April, 1910, the price of rubber reached its record figure of 12/10d. per lb., and averaged 8/9d. per lb. for the whole year; but as only 10,000 tons of plantation rubber were produced in

1910, against 75,000 tons wild rubber, the producers of the wild rubber derived most of the benefit of the high prices.

The stimulus of the high price and the certainty of the greatly increasing demand for crude rubber (the automobile registration in the United States increased from 311,000 in 1909 to 1,287,000 in 1913) led to the " rubber boom " of 1910, which resulted in about 1,000,000 acres being planted in the years 1910, 1911 and 1912. From 1913 to 1920, planting appears to have proceeded at a more or less uniform rate of over 200,000 acres per annum. This was partly the completion of planting programmes drawn up under the influence of the boom of 1910, but in some of the Malay States, at least, it was made a condition of each grant of land for rubber cultivation that a minimum proportion of the land had to be planted each year, so that extensions were necessary unless land was to be surrendered. In the last 10 years an increasing amount of rubber has been planted by small native cultivators throughout the whole East, especially in Malaya, where the native transferred his energies from the cultivation of fruit and tapioca and turned his attention to rubber. By the end of 1921 nearly 4,000,000 acres had been planted throughout the East, and of this about 1,200,000 acres were in the possession of small native holders.

The production of plantation rubber in 1910 was 10,000 tons; in 1920 it had increased to 335,000 tons. In 1922 the potential production (allowing for the resting of the trees in the previous year) would have been about 430,000 tons, but owing to restriction of output voluntarily practised by a considerable number of estates, together with the low price of rubber during the greater part of the year, only 375,000 tons of plantation rubber were produced. The output of wild rubber dropped steadily from 75,000 tons in 1910 to 35,000 tons in 1920, and in 1923 it was only 25,000 tons. The stimulus of high prices during the years 1906-1912 seems to have had little effect on the production of wild rubber. In the case of South American rubber collectors, a high price means that they collect less rubber—even the phenomenal prices of 1910 had little effect on their output. In so far, therefore, as the development of the rubber manufacturing industry depended on increasing supplies of rubber at a reasonable price, it was entirely due to the energy and foresight of those engaged in the plantation industry that such supplies were forthcoming. Indeed, it is hardly too much to say that the rapid development of the automobile industry would have been inconceivable, owing to lack of supplies of crude rubber, if the plantation industry had not been available to furnish those supplies as they were wanted.

The total area under rubber at the end of 1921, the latest date for which we have data for most of the countries, was as stated above, about 4,000,000 acres, of which about 2,400,000 acres, or 60 per cent. were actually tapped. With regard to the area tapped, however, it should be remembered that 1921 was a year of acute depression in the industry, and voluntary restriction was in force on the majority of estates. Considerable areas of older rubber

were rested throughout the whole period, and it was not profitable to tap the youngest rubber. Hence the area tappable is likely to be significantly greater than the area actually tapped. This applies in varying degrees to Malaya, the Netherlands East Indies, Ceylon and other countries producing plantation rubber.

We might now consider briefly the distribution of the planted area amongst the various producing countries.

1. British Malaya.—The first official census of the area under rubber in British Malaya was taken in the autumn of 1921, and the results show that a total of 2,226,000 acres were planted, of which 1,317,000 acres were tapped. Malaya, therefore, possesses 55 per cent. of the total area planted with rubber. Further, of the 2,226,000 acres planted in Malaya, 900,000 acres, or 40 per cent., were in holdings of 100 acres and under, practically the whole of which were owned by natives. During 1921, about 480,000 acres of plantations of under 100 acres were tapped.

2. The Netherlands East Indies.—It is unfortunate that no complete census of the area under rubber in the Netherlands East Indies has yet been made. The Statistical Office of the "Department of Agriculture, Industry and Trade," publish acreage figures annually, but it is doubtful if these figures include much, if any, of the acreage of the small native holdings. The report for the year 1921 showed that 900,000 acres were planted, of which 560,000 acres were tapped; while that for 1922 showed a planted area of 920,000 acres, of which 580,000 acres were tapped, and this appears to be mainly from large estates. Unofficial data, which must be received with caution, gives the number of trees planted by natives at the end of 1922 at about 55,000,000, and the average number of trees per acre at 300. If these figures are even approximate it would appear that the total area of native rubber in the Netherlands East Indies would be about 200,000 acres, or nearly 20 per cent. of a total planted area of 1,120,000 acres at the end of 1922. The area under rubber in the Netherlands East Indies is thus about 28 per cent. of the total area planted with rubber.

3. Ceylon.—A census of the area under rubber in Ceylon was taken for the year ending 30th September, 1921, and the results show that the total planted area in the Island was 390,000 acres, of which about 315,000 acres were tapped. Of the 390,000 acres 87,000 acres, or between 20 per cent. and 25 per cent., were in the possession of small native holders.

4. Other Countries.—Amongst the other countries which cultivate rubber India takes the first place with a planted area at the end of 1921 of 124,000 acres, half of which was tapped. This acreage is divided almost equally between South India and Burma. Next in importance is French Indo-China, which at the end of 1921 had nearly 70,000 acres planted, of which between

30,000 and 35,000 acres were tapped. Finally, over 100,000 acres are planted in other places, mainly in British North Borneo and Sarawak, and about half of this was tapped at the end of 1921.

It will be obvious from the foregoing that the output of rubber from small native holdings has now become a factor of considerable and increasing importance. These holdings represent altogether 30 per cent. of the total planted area, and 75 per cent. of their total area is in Malaya. Unfortunately, our information with regard to them is still very defective; even in those districts where an official census of the area under rubber had been made the data collected for the native areas is admittedly much less accurate than those for the larger estates, which are mainly owned and managed by Europeans. The method which has been adopted in the census for some districts is to enumerate the trees and calculate the acreage on the basis of a fixed number of trees per acre, and, as many of the natives have not a very accurate idea of the size of their plantations, this method would probably give as reliable results as can be obtained under existing conditions.

Until a proper census of all the native holdings in the East has been made it is, of course, impossible to give any reliable figure for the average yield per acre and general productivity of such holdings. The assessments under the Restriction Scheme for Malaya and Ceylon for small native holdings were made on a somewhat generous scale, and furnish little indication of their present or future potential output.

The Ceylon census above referred to for the year ending 30th September, 1921, however, gave the total yield of rubber for the native holdings. From the data published it would appear that the average yield per acre was probably between 160 and 180 lbs. for that year, and that the output of the native holdings was an exceedingly abnormal year, owing to the fact that most of the European estates were restricting output during the whole or part of it, and it may be taken that the low price meant some restriction also amongst the natives.

With regard to the Netherlands Indies, the exports of native rubber during 1922 and 1923 were respectively about 23,000 tons and 51,000 tons, but a reduction of about 30 per cent. has to be made from these figures to allow for moisture and other impurities.

In many districts, especially in the Netherlands Indies, the native is not entirely dependent on his rubber. When the price of rubber was very low during 1921-22, the native output, in Netherlands Indies at least, diminished very considerably, and it also seems likely that, wherever possible, the native of Malaya and Ceylon also ceased tapping and turned aside to other cultures until the price of rubber made it profitable to again tap his trees. In many cases the native abandoned his holding, which therefore

became a mere breeding place for disease, and so a constant source of danger to neighbouring estates.

It is, of course, well known that most of the small native holdings have been over-tapped in the past, and are still being over-tapped, that they have been badly looked after, and that, as a consequence, disease has been, and still is, fairly prevalent. It is probable, therefore, that a considerable proportion of the acreage owned by natives will be unable to produce much rubber a few years hence. But, until we have a great deal more information about such holdings than we have at present, it is impossible to make even a rough prediction of their performance for the next few years. It seems likely that in the near future the Governments of Malaya and Ceylon will make a new and much more complete census of the acreage and output of native rubber in the territories under their jurisdiction, and it is highly desirable that the Netherlands Indies Government should carry out a similar census in the Dutch Indies.

The necessity for proper census of the Dutch native rubber is now recognised by the Dutch planters themselves, and at a representative meeting held at Djokja about the end of February they recommended that an International Commission must be appointed in order to investigate as soon as possible the extent and potentialities of native holdings in the Dutch East Indies.

In considering the relative position of the larger estates and the small native holdings, however, the acreage figures alone are not sufficient; other factors have to be considered. The quality of the output is very important. About 85 per cent. of the production of the estates is first-grade rubber, and this, together with the bulk of the off grades, goes straight to the manufacturer without going through any further process. In the case of the small native holder his preparation processes are much more crude and primitive than those on the estate, and his rubber contains anything from 15 per cent. to 35 per cent. moisture and impurities. Consequently, practically the whole of it has to be remilled before it can be marketed. He has therefore no direct access to the rubber markets of the world, and he must dispose of his product to a native dealer. His low costs of production and his inability to look into the future make him indeed a formidable competitor to the estate at the present time; but the over-tapping and general neglect of his holding will tell against him in the future, and unless he continues to plant fresh trees his output will fall off. It is therefore essential for the stability of the industry that the various governments concerned should make annual reports on the extent and condition of the native holdings.

There are two recent developments which may have a considerable effect on the future development of the industry, and also on the relative production of estate and native rubber. The first is the movement to obtain better yielding trees on the estates, either by seed-selection or by bud-grafting. The results of this movement may not be immediately perceptible, but in a few years' time, if these selective efforts are sustained and extended,

it is certain that the average yield per acre of estate rubber will be greater than it is to-day. The second development is the shipment of rubber in the latex form. This began in 1922, when about a quarter of a million gallons were shipped. Last year the shipments amounted to about 1½ million gallons. Although the adoption of latex in paper making has been very much less prevalent than was anticipated two years ago, the preparation of rubber by spraying the latex in a current of hot air may have definite possibilities owing to the uniformity obtained by bulking large quantities of latex and to the increased rate of cure. If at some future time the bulk of the rubber should be shipped in the latex form, the native would have to greatly improve his methods of collection if he is to compete successfully with estate latex, apart from the fact that his transport costs will be heavier.

Since the incidence of the slump there has been a considerable amount of amalgamation amongst rubber companies, although the number of independent producers (excluding small native holders) is still very large. It is impossible to estimate with any degree of accuracy what this number is, but it is certainly over 1,000, and may well be over 2,000. It is probable that this movement towards consolidation of numbers of existing companies into larger units may continue at an accelerated rate during the next few decades, when the present multiplicity of independent entities will give place to a comparatively few large, well-organised and financially strong producers. The need of such an organisation in the production of crude rubber will become obvious when it is remembered that half the annual world absorption of crude rubber is in the hands of five large manufacturing firms.

The absorption of crude rubber by manufacturers increased rapidly from 90,000 tons in 1910 to 330,000 tons in 1919, and, while it decreased to 310,000 tons in 1920, and to 265,000 tons in 1921, it again increased in 1922 to about 385,000 tons and to about 405,000 tons in 1923.

Up to the middle of 1920, when the acute depression in the industry began, production and absorption seem to have kept pace with each other, due allowance being made for the increase in stocks necessary for the normal development of an expanding industry. The conditions existing during the period of depression from the middle of 1920 to the present day will be considered in a paper by Mr. H. Eric Miller, but it may be pertinently pointed out here that, between 1910 and the middle of 1920, the average annual absorption of crude rubber increased fourfold, while the average annual price, though generally falling, was never so low as 2s. per lb. The assertion that rubber at 2s. would hamper the future development of the rubber manufacturing industry finds no support, therefore, in the period of its greatest development in the past.

The two tables which follow give a summary of the more important statistics of the industry. The first gives the total area under rubber and the area actually tapped at the end of 1921, and the second gives the total world production and absorp-

tion of crude rubber and the average price of first latex crepe from 1910 to 1923.

AREA UNDER PLANTATION RUBBER AT THE END OF 1921.

		Planted Acres.	Bearing Acres
MALAYA:			
Federated Malay States	1,235,000	791,000	
Unfederated Malay States	665,000	323,000	
Straits Settlements	326,000	203,000	
	2,226,000		1,317,000
NETHERLANDS EAST INDIES:			
Java	399,000	248,000	
Sumatra (East Coast)	363,000	246,000	
Other Districts including estimated Native Rubber	334,000	115,000	
	1,096,000		609,000
CEYLON	390,000		315,000
INDIA	124,000		61,000
BRITISH NORTH BORNEO	50,000		30,000
SARAWAK	40,000		16,000
FRENCH INDO-CHINA	69,000		32,000
OTHER COUNTRIES	20,000		10,000
GRAND TOTAL	4,015,000		2,390,000

NOTES.—(1) There are no authentic data regarding the Native Rubber in the Netherlands East Indies, but it is generally assumed that over 55,000,000 trees were planted by the end of 1922. The number of trees per acre appears to vary considerably from holding to holding, and such data as exists points to an average of about 300. In the above table the area in the Netherlands Indies planted with Native Rubber at the end of 1921 has been estimated at 200,000 acres, and the area tapped at 50,000 acres.

(2) The figures given in the column under "Bearing" represent the areas actually tapped during 1921. As there was a considerable amount of restriction practised during that year the total "tappable" area was probably significantly greater than 2,390,000 acres.

CRUDE RUBBER STATISTICS, 1910-1923.

	Production.			Absorption.	Average (*b*) price
Year.	Plantation. tons.	Wild. tons.	Total. tons.	tons.	per lb.
1910	10,000	75,000	85,000	90,000	8/9
1911	18,000	67,000	85,000	85,000	5/5½
1912	34,000	71,000	105,000	95,000	4/9
1913	57,000	63,000	120,000	105,000	3/0¼
1914	83,000	47,000	130,000	120,000	2/3½
1915	121,000	44,000	165,000	150,000	2/6
1916	170,000	45,000	215,000	180,000	2/10¼
1917	223,000	47,000	270,000	230,000	2/9¾
1918	241,000	34,000	275,000	220,000	2/3½
1919	302,000	38,000	340,000	330,000	2/1¼
1920	335,000	35,000	370,000	310,000	1/11
1921	263,000	22,000	285,000	265,000	10½
1922	375,000	25,000	400,000	385,000	9⅛
1923	345,000 (*a*)	25,000	370,000 (*a*)	405,000	1/3¼

(*a*) Exportable production. (*b*) First latex crepe.

THE PRODUCTION OF "SYLVESTER," OR WILD RUBBER AND PLANTATION RUBBER IN THE FRENCH COLONIES.

By AUG. CHEVALIER,

Head of the "Mission Permanente d'Agriculture Coloniale au Ministère des Colonies," Director of the "Laboratoire d'Agronomie Coloniale près du Muséum d'Histoire Naturelle."

The CHAIRMAN (Mr. P. J. Burgess) read Prof. Chevalier's paper, viz. :—

During the past year, French industry has absorbed 28,000 tons of raw rubber, out of the 400,000 tons which form the world's production. About one-sixth of the quantity we have used came from the French Colonies. Within a short time we will be able to produce, in the Hevea plantations of Indo-China, about one-quarter of our national consumption. Rubber plantations came into being only recently. Until 1910, the greater part of the rubber utilised in the world was produced by trees and creepers growing wild in all the tropical regions of the earth, and chiefly by the "Hevea Brasiliensis" (Para rubber) from the forests of the Amazon. That tree was introduced in the Middle-Orient, in 1876; the first plantations began in 1890. They cover to-day 1,200,000 H.A. (2,900,000 acres) in the Federated Malay States, in Java, Sumatra, Ceylon, and in a few neighbouring regions. Since 1920, the Hevea plantations supply over nine-tenths of the quantity of rubber used in the world.

In a recent essay I have shown how the culture of Hevea has gradually developed and improved, and I have also pointed out the remarkable progress made in tropical agriculture due to the improvements in the planting of rubber-trees on a large scale.*

I intend to show here the consequences of that evolution as regards the French Colonies.

The "Sylvester" Rubber in the French Colonies.

Until 1880, most of the rubber used in Europe (about 15,000 tons) was imported from South America. From that date, producing specimens were discovered in the forests and in the jungle of nearly all the tropical regions of the world.

In 1898, the world's consumption amounted to 50,000 tons, and the production, being inadequate to the needs of the industry, there came a real rush for rubber. Nearly all the European countries organised missions to go and discover new producing plants in all the tropical regions. For about 20 years, entrusted by the Ministry of Colonies with one of these missions, I have travelled all the jungle and the forests of our Colonial possessions

*Aug. Chevalier: "La Production du Caoutchouc dans le Monde et son Evolution." "Revue Scientifique," 12 Janvier, 1924, p. 4.

in Africa and Asia in search, not only of rubber plants, but also of all plants which might yield useful raw material (gums, oily seeds, resins, fibres, wood, etc.).

Tropical Africa is, with South America, the richest country in latex plants. It is there that several specimens are to be found, amongst which the *Dophia,* splendid creepers rising to the top of the trees, and of which the long drooping branches are covered with white perfumed flowers; the little *Clitandra* and *Landolphia,* which bloom near the ground owing to the jungle fires that destroy them every year, but which yield rubber from their underground bulbs; the *Rhaphionacme,* of Angola, small grass with large bulbs, full of latex, the ficus similar to the specimen we grow indoors, and which, in Africa, grows more often as a parasite on the tree, and in which birds store their seeds; finally the *Funtumia elastica,* a very dainty specimen, which grows in the depths of the forests, where, as a result of being over-tapped, it has been almost exterminated.

It was in 1906 and 1907 that the production of " Sylvester " rubber reached its highest point. For a total production of about 70,000 tons, plantation rubber only reached about 1,000 tons. Brazil supplied about half of the world's production. The whole of tropical Africa produced 25,000 tons, which is about one-third of the world's consumption; our tropical Colonies supplied from 5,000 to 6,000 tons, of which two-thirds came from West Africa and Equatorial Africa; the " Sylvester " rubber, which was then of great value, represented for those countries a considerable wealth. To-day, the conditions are reversed. The production of our Colonies in Africa only amounts to 1,000 or 2,000 tons of low-grade rubber. Madagascar, Tonkin, New Caledonia do not supply any more.

I have explained elsewhere the reasons of that downfall; I will only enumerate them here once again.

First of all, one has to take into account the exhaustion, or the destruction, of the old trees, which have not been replaced by new ones or by plantation.

Another cause has to be found in the insufficient improvement in the quality of the " Sylvester " rubber, which, being badly prepared, or containing too many impurities, is no longer in demand. Plantation rubber, always more clean and uniform, gives less trouble to the manufacturers. It has often been said that wild rubber frequently possessed more " nerve " than the rubber from Hevea plantations. That is hardly believable, however, when one notices that the manufacturer of to-day is quite content to use the latter, and even pay a higher price for it, excepting Para rubber yielded by other trees.

Finally, as a result of the fall of the prices of rubber and its rarefication in the jungle, the natives of certain countries find more advantage in undertaking cultivations. This has to be considered as a progress, because, if the tapping of wild rubber has helped in a certain measure the progress of West Africa, it has meant for Equatorial Africa a hard and very badly

remunerated drudgery, and has resulted in numerous abuses which I do not want to lay stress upon here.

Many theoretical regulations, inspired by the best intentions, have been introduced for many years in order to try and improve the situation. They have, however, not yielded the expected results. Firstly, one wanted to preserve the trees, and replenish those which were exhausted; to teach the natives how to cut the trees and creepers properly, and to obtain rubber of good quality. Only very poor results were obtained. It has been possible to educate the natives of Indo-Malaysia in organised plantations, with coolies divided into squads, supervised and controlled by Europeans. It would, however, be childish to think that theoretical regulations and texts are sufficient to modify the habits of numerous tribes, with very different aptitudes, who would have to tap in mid-forest or mid-jungle, away from European supervision. In order to make similar regulations efficient, there should be a fully organised forest system, an elaborate and specialised wheel-work, with continual supervision, and, even then, that supervision would only be able to exist, as in Indo-China, on narrow forest reserves, with fixed boundaries, possessing a complete and well-trained staff. This does not exist, and it does not seem likely that it will come into being for a long time, for financial reasons, either in French West Africa or in French Equatorial Africa.

In Equatorial Africa, the collection of wild rubber has been one of the chief causes of the decline of that country. It has not proved profitable to the natives; I do not believe that it has made companies rich, but I am sure that it has not helped the progress of the country. Where, as on the plantations, it is possible for a native to collect, in one morning, the latex necessary to prepare 3 kilos. of rubber, it is usually reckoned that, in the jungle, a native will take from 5 to 10 days to produce one kilogram of rubber. In order to be able to pay the tax in one village in the Congo, or in the Oubangui, all the men of that village would have to stay for weeks in mid-forest, neglecting during that time the cultivations they subsist on, and they would have to live there in the most unhealthy conditions. It would have been better if, on appropriated grounds, each village could have cultivated small rubber plantations, which would have grown in a few years into a more profitable and easy enterprise than using the wild trees. But when one remembers the numerous problems that have cropped up in Indo-Malaysia, in the organisation of Hevea cultivation, the financial efforts, the numerous experiments made by planters and learned men, who already had experience in tropical agriculture, it is not at all surprising that that cultivation has not been introduced in Africa. The first Hevea plants grown from the seeds of the chemist, Raoul, and brought by M. Paul Bourdarie to the principal experimental gardens of the French Colonies of the West Coast of Africa, remained there for more than 15 years before it was thought of tapping them systematically. The other nations have not been more successful than we. In Africa, and, even in Brazil, the cultivation of " Sylvester " rubber shows a

rapid decline, and there is not a single plantation of wild rubber whose efficiency is greater than that of a Hevea plantation.

Hevea Plantations in Indo-China.

In order not to remain under the gloomy impression the above description may have caused, I will hastily pass over, and talk about the beautiful Hevea plantations which are in existence to-day in South Indo-China. Created by about one hundred French planters, who settled down as it were on the plantations themselves, and by various small officials of that colony who have given to agriculture all their spare time, these plantations have to-day given magnificent results. This success shows that, if we only tried, we could produce, not exactly all the exotic raw material that we use—our Colonies are not thickly enough populated for that purpose—but, at least, a greater part of these materials. To that end, what is simply needed is capital and a selection of experienced planters. During my travels I have noticed, in foreign colonies, as well as in our own, that when a cultivation is being developed in a new country, one always finds a small nucleus of obstinate men settled down in a country they like, clever in handling natives, of strong temperament, and who, in former days, were pioneers of the cultivation of sugar-cane in the Antilles, of coffee in Bourbon, of spices in India. The planters of Cochin China have been worthy competitors of these early pioneers.

On the 31st December, 1923, it was reckoned that, in Cochin China and the adjacent parts of Annam and Cambodge, 33,291 H.A. (83,000 acres) of Hevea plantations were organised, on which 4,437,000 trees were regularly tapped. The production has amounted to 4,450 tons of rubber, in spite of the restrictions in tapping which numerous planters have voluntarily adopted. Within a short time the production will reach 8,000 tons. The actual consumption of rubber in France, in 1923, was 28,000 tons, which will mean a very valuable help to our industry.

The plantations of Cochin China have, for the greater part, been brought into existence by men who had no experience in colonial agriculture, and who only had small capital at their disposal. In order to succeed, they had to learn, and having faith in the ultimate result of their enterprise, they have not been set back by the difficulties they encountered.

The introduction of Hevea plantations was due to the initiative of the marine-chemist, Raoul, who was entrusted with a mission to the Far East. From Java, he sent seeds to the Botanical Garden at Saigon for raising the first plants. The young plants were placed at the experimental agricultural station of Ong-Yen (Cochin China), and also at the station of the Pasteur Institute at Suoi-Gae, in South Annam. About the same period, a modest planter, M. Belland, introduced Hevea seeds from Singapore for the purpose of starting a small plantation in the neighbourhood of Saigon, which was first tapped in 1906. The year 1907 can be considered the starting-point of the planting industry, which

was to have such a great future in Cochin China. It can also be said that the success of the Malayan planters was a great stimulus to the French planters. It was in the region of Singapore that most of our planters gained their knowledge, and it was from here that many obtained seeds which enabled them to open up the first plantations. The boom of 1909, during which rubber was sold at 25 to 30 francs the kilogram, brought the final touch to the evolution of that cultivation. In 1910, 1,400,000 trees were planted. In 1914, the area planted in Cochin China was estimated to be 14,174 Hectares (35,000 acres), and the capital invested amounted to 30 million francs. Since then, those figures have increased considerably. * Most of the plantations in Cochin China are of average size—from about 150 (371 acres) to 500 Hectares (1,420 acres). A few others, particularly those from Xa-trach, Hiep-tanh, Suzannah, Anloc, the Hallet Group, etc., extend to over 500, and even 1,000, Hectares (2,470 acres).

The plantations of the " Société des Caoutchoucs de l'Indochine " cover 2,500 Ha (5,930 acres) at Loc-ninh. In order to be complete I have also to mention a certain number of small plantations, covering less than 100 Ha (247 acres) each, and amongst which several belong to natives. The small plantations are those which yield often the most appreciable profits proportionately to the capital invested, because the overhead expense is very small and only cheap labour taken from neighbouring villages is utilised.

Unfortunately, on certain of those small plantations the improvements are not what they should be. The diseases of Hevea there are very frequent, hence the necessity for the colonial Governments to utilise the services of pathological supervision.

On the large plantations, especially on those which are situated on the sites of old forests or old bamboo forests and surrounding red grounds, intensive cultivation is adopted; mechanical cultivation, manuring, fight against disease, alternate tapping, selection of the plants for replacing diseased ones, are all practised.

The coagulation of the latex is carried out in factories equipped with all the modern appliances found in the large plantations of Malaya and Ceylon. Experiments made on a big scale have shown that the cultivation of rubber, coffee, cocoa, and oil palms can be undertaken on large areas of the fertile colony of Indo-China without any trouble, provided it is conducted with capability and care.

I would like to mention the valuable part played here by a few Frenchmen who were the pioneers of that cultivation. It was Mr. Capus who, as associate to Mr. Doumer, made the first official tests of Hevea cultivation, and who exhibited the first plantation rubber from the French colonies at the Colonial Exhibition of Marseilles in 1906. It is to Dr. Calmette that the honour is due of having started, with his friend Dr. Yersin, the beautiful plantation of the Pasteur Institute of Nhatrang, which at the present time constitutes one of the chief resources of the great scientific

*The actual valuation must evidently be made in golden francs.

establishment in the Far East. It was then M. Haffner, director of the Botanical Gardens of Saigon, who installed the first official experimental station at Ong-Iem, which was afterwards remarkably well directed by the late Morange. Finally, in 1907, at Suzannah, M. Girard started the first large plantation, and since then he has not ceased to improve that cultivation.

These first plantations have been the starting-point of the movement which has led to the actual development, but one has not gone far enough yet. The cultivation of Hevea itself can still be considerably developed in Indo-China. The crisis of the overproduction of rubber is only temporary, and, as soon as the situation in Europe improves, it is certain that the demand for raw material will increase. As a matter of fact, the plantations of Indo-China, as they stand at present, will only yield one-quarter of the quantity of rubber which France will require two or three years hence, even if new uses of that material do not arise. There are still large uncultivated areas of fertile ground in Indo-China, as well in Cambodge and in Cochin China, within easy reach, where cultivation can be developed. Labour could easily be found in Tonkin. The system of concessions there is more liberal than in Sumatra or in the Federated States.

On the red grounds, in addition to Hevea, cocao, coffee, cotton and oil palms can also be cultivated. Remarkable work has already been done, but it is of primary necessity that it should be continued and developed in our beautiful colony of Asia.

I do not think it advisable to start afresh with the cultivation of rubber plants in tropical Africa, nor to impose it on the natives. Indo-Malaysia and even Indo-China have gone such a pace in the progress of that cultivation that it seems unreasonable to make new, costly experience schools in Africa which would only yield very doubtful results.

The failure of the methods of tapping wild rubber must be a lesson to us for the future. That process of working only lasts a short time, even amongst the primitive tribes. Sooner or later the cultivation imposes itself, and that method of collection nearly always leads to the destruction of the natural stock, just as the working of forests, when not combined with sylviculture, ruins them, even more so in the tropical than in the temperate regions.

It is thus towards agriculture, which constantly creates new wealth, that the native has to be guided. But if we want to obtain good results we have to take his needs more into account than our own, and not make him undertake anything that is beyond his capabilities, and also take into account the aptitude of each tribe.

If a cultivation is ancient and traditional in a country, as is the case with the cultivation of cotton by the negroes of Tropical Africa, it has great opportunities of developing itself and of improving if encouraged.

Therefore, because the method of tapping the " Sylvester rubber " is not remunerative enough to the natives, we have to

seek and substitute the extensions in cultivation of cotton and oil plants, which the negro grows already, and which he will be able to develop and improve, provided we grant him the indispensable help and encouragement. This work of high utility asks for much care, method, and spirit of co-ordination from the colonising countries, but it has a valuable bearing on the progress of civilisation.

ACCOUNTANCY AND METHOD OF COSTING IN THE RUBBER PLANTATION INDUSTRY.

By J. G. HAY.

Mr. P. J. BURGESS, who presided, said: I have pleasure in introducing Mr. Hay, who will read a paper on "Accountancy and Methods of Costing in the Rubber Plantation Industry." I am very sorry, not so much for our sakes as for the sake of those who are absent, that more are not here to listen to the paper. It is a subject which is unrepresented at present in the literature of rubber affairs, and it is a subject which Mr. Hay has made very much his own. He has had very great experience in this side of the work, and as it is breaking fresh ground there may be a very considerable opportunity for discussion. I will now ask Mr. Hay to read his paper.

Mr. J. G. HAY:

The Rubber Industry, being a comparatively young one, and financed largely by Joint Stock enterprise, has naturally and necessarily adopted and maintained from its inception a practical and effective costing system. In that respect it has perhaps shown to advantage over some of the older forms of agriculture, more extensively held and managed by private owners, some of whom to this day rely on a somewhat primitive and haphazard method of accountancy. Without an effective costing system it is very doubtful whether the Rubber Industry would have so far succeeded in effecting substantial economies to meet the depression which set in in 1920 and continued progressively more intense until relieved in the latter part of 1922 by the operation of the Stevenson Scheme.

With ownership so widely spread, a general interest in rubber costs has always been displayed, but that interest was greatly quickened and intensified by the dramatic fall in the price of rubber which took place during the period to which I have just alluded. The anxiety of the investor to check the fall in his securities, the schemes and methods advanced and discussed in private and in public for rescuing the industry from the severe depression which had overtaken it, all tended to focus attention on expenditure involved in production. The figure upon which the Stevenson Scheme pivots was doubtless fixed on the basis of cost of production, and those who at one time assailed it armed themselves with arguments based on costs of production which might have aroused our envy and admiration had we not known that such figures did not represent true costs. Such weapons, made from

material so flimsy, crumpled up against the hard realities of the case.

I have alluded to these matters to show that the circumstances and the occasion are not inappropriate for explaining, as far as it is possible to do so within the compass of a brief paper, the method of arriving at costs in the Rubber Plantation Industry. It is not improbable that some here are intimately acquainted with the subject matter of my paper. I may on one or two points challenge their opinion, but for the greater part I shall rely on their patience and forbearance. If this contribution should succeed in removing some of the misconceptions regarding rubber costs which are entertained by others, I shall not have failed in my purpose.

The scheme which I propose to follow is to give first the broad outline of the usual system of accountancy followed by rubber companies, following that up with a description of the usual methods adopted to check the expenditure in the East, and lastly to touch briefly on the usual methods of costing.

First, the broad outline. Owing to the distance which separates most rubber estates from their head office, it is necessary to keep the books which record the transactions of the Company partly on the estate and partly at the head office. The estate books record the numerous disbursements which are involved in running a rubber plantation, while the head office books record the periodical remittances made to the East, transactions relating to the selling of rubber and the payment of all charges incidental thereto, head office expenses, etc. In addition, head office books contain share capital and reserve and profit and loss accounts, and should also contain such accounts as estate property account and estate equipment account which form the fixed and permanent assets of the company. The old custom of recording in the head office books the details of estate expenditure has long since been discarded, on the grounds that it is unnecessary to record the same transactions in two separate sets of books. The link between the estate books and the head office books is an account called on the estate "Head Office Account," and at home called "Estate Account," the balance of which represents the amount to be accounted for by one place to the other. In short, the method employed conforms to the usual and well-known head office and branch accounts system.

Now, having got the broad outline of the method employed, we pass on to examine the system devised for controlling and checking expenditure. Let us assume that the directors at home have settled their programme for the next fiscal period and communicated it to their agents or manager. The next step has to be taken in the East. The manager proceeds to draw up detailed estimates of works authorised, such estimates in most cases being examined and revised by the agents in the East and forwarded home in time—we hope—to permit of an analysis and examination, and of their decision or revisions reaching the manager before the fiscal period to which the estimates relate has actually begun. As an appendix to this paper I exhibit a form of estimates such as is in common use. Here may I say that in exhibiting any such forms I am not claiming for them a superior merit over others that may

be in use. I submit them as illustrating a general practice in the trade. Although in actual practice it is not improbable that some amendments on the manager's estimates may be made for greater economy, we shall assume for present purposes that the estimates as presented are approved by the Board and such approval conveyed to the Eastern agents or the manager. The estate manager is now at liberty to proceed with his programme of work. Prior to the commencement of each month the manager estimates his probable cash requirements, and this amount is put at his disposal. At the end of each month the manager sends to his head office an account showing what he has done with the money put at his disposal. This account is known as the Monthly Estate Report Account, and corresponds in form to the estimates, and the totals of each item of expenditure are contrasted in parallel column with the estimated expenditure. At the end of the year the manager's accounts are audited on the estate, and all expenditure transferred to head office account for final consideration by the directors along with the Eastern auditors' report.

Having progressed so far, we are now approaching closely to the substance of our subject—namely our costing system. This I propose to consider under the headings of:—

(1) Class of Estate.
(2) Unit of Cost.
(3) Classification of Expenditure under different sub-heads.
(4) Certain controversial points.

First, *Class of Estate.*

For the purposes of this paper we might divide rubber estates into three classes:—

(1) Estates wholly mature.
(2) ,, partly mature and partly immature.
(3) ,, wholly immature.

Second, *Unit of Cost.*

All expenditure on estates within our first category is obviously wholly debited to revenue account, and the unit of cost is the pound of rubber. Expenditure on estates in the third category is necessarily a charge against capital account, and the unit of cost is the acre. Expenditure on estates in the second category is obviously partly capital and partly revenue, and the unit of cost is, as before, the acre for capital expenditure and the pound of rubber for revenue expenditure. If you will glance at pages 4 and 5 of the specimen Monthly Estate Report you will see that columns are provided for contrasting the cost of the various kinds of expenditure worked out on these units with the estimated cost for the year.

Third, *Classification of Expenditure.*

Let us examine the "Monthly Estate Report Account." It divides itself naturally into three parts. First, it sets out in great detail every item of expenditure. It has been said by one authority that accountancy is a narrative of things that have happened. This detail of expenditure is the managers' or agents' narrative

truly and accurately told. Secondly, it provides a medium for the analysis of expenditure incurred; and thirdly, it provides valuable statistical information and a statement of balances for adjustment with head office. I need not enter into a more detailed description of Monthly Estate Report Account, since I have here for examination and inspection a specimen form, but I wish to direct your special attention to that part which deals with the analysis of expenditure. The method by which we dissect cost is fully illustrated on pages 3, 4, and 5 of the specimen form now before you. The main headings under which expenditure may be grouped are as follows :—

Revenue Expenditure.

(1) General Charges.
(2) Repairs to Estate Equipment.
(3) Cultivation of Mature Area.
(4) Collection and Manufacture.

Capital Expenditure.

(1) General Charges.
(2) Cultivation of Immature Area.
(3) New Clearings.
(4) Estate Equipment.

Each heading is further dissected and analysed to such an extent that expenditure on an estate containing mature and immature rubber and new clearings will probably range over 80 items or even more. It will thus be seen that the analysis in practice is severe, and provides a means of following closely and clearly the source and occasion for all and every form of expenditure.

General Charges represents all overhead expenses incurred on the estate, and comprises about 20 different items, such as salaries, allowances, transport expenses, medical and estate office expenses, insurance, etc., etc.

Repairs to Estate Equipment cover the expenses incidental to maintaining all buildings and machinery, but the full details of expenditure under these headings are set out in the specimen form before you, and I need not therefore recapitulate here. I should emphasise, however, that " collection and manufacture " include packing, local transport, and export duty (if any), and such expense as is incidental to placing the rubber on the steamer at port of shipment.

Fourth, *Certain Controversial Points.*

So far all has been matter which is practically agreed upon by all members of the industry; but now I come to my fourth heading, involving more controversial matters. These arise partly in con-

nection with what is called the f.o.b. cost and partly in connection with computing the " all-in " cost. First of all we must determine at what time or at what stage an area of rubber passes from immaturity to maturity, and the expenditure is to be transferred from the capital account to revenue account. If we wait until all trees are in tapping, then some proportion of the property will become a capital charge in perpetuity, since on no property can 100 per cent. of the trees be safely kept in the tapping round indefinitely, however sound the system of tapping may be. Speaking generally, five years, reckoned from the date of planting, is the period that elapses before a tree becomes ripe for tapping. But since growth must necessarily vary according to soil treatment, climatic conditions, etc., five years may be ample time in some cases, but somewhat short in others. But, again, unless we are to be led into the unsound practice of capitalising expenditure indefinitely, we must set a definite period within which capital expenditure on any particular area must cease. For general application a safe ruling would be that when 60 per cent. or more of the trees in a given area have reached a tappable stage that area should pass over to Revenue Account. When the percentage is less, a *pro rata* proportion of the area should be so transferred subject to all areas at the end of six years ceasing to be a charge on Capital Account. A definite period is therefore put to capital expenditure, and any attempt to secure profits at the expense of capital is defeated. It must be recognised that once an area has become a revenue charge it cannot, if sound methods of accountancy are to be maintained, pass back again to Capital, despite the fact that such area is put out of tapping. The adoption of any other course would involve a writing up of capital assets without proper disclosure. I can conceive of only one qualification :— Where a property changes hands and the purchaser has bought rubber mature according to age but immature according to state and price, then he may be justified in respect of areas which he may not tap in making them a charge to Capital. But such a purchase is in effect a writing down of Capital to such an extent as fairly permits of additional capital expenditure being charged without undue inflation.

Next we pass on to the question of apportioning indirect expenditure, or what is commonly known as General Charges. Since these charges are incurred on account of mature and immature areas, they must be divided by some equitable and sound method between Capital and Revenue. Up to this point the method of costing I have described is common to most proprietors, but on the question of the distribution of General Charges there is a diversity of methods and a variety of opinions.

Time does not permit of an examination of all the methods in use or the many opinions held, so we shall for present purposes

confine ourselves to two methods more commonly in use than others :—

(1) The apportionment of General Charges on the basis of wages.

(2) The apportionment on the basis of acreage.

While I do not wish to appear dogmatic on this matter, it seems to me that, while neither method is strictly scientific, the second course provides the sounder basis. Many items included in the omnibus item General Charges have little or no relation to wages at all. If you will refer to page 3 of the Estate Report you will observe that, while a few of the items may bear some relation to coolie wages, for the greater part they are payments made for supervision and management of the whole property, while expenditure under other items is actually determined by acreage. Moreover, the not uncommon use of contract labour furnishes another objection to the wages basis. Under the operation of contract labour the manager may have no certain knowledge of wages paid to contractors' coolies, the number of coolies employed, or the average daily number working in any one month. Contract labour to a great extent supplies its own supervision, and is generally paid on the basis of work actually done—if cultivation work, according to acreage; if tapping, then according to latex returned.

It seems to me that the more correct view is that General Charges are incurred for the benefit of the whole cultivated area, and should be divided on an acreage basis. But, having found the basis, I do not subscribe to the idea that General Charges should be divided on the assumption that a mature acre carries the same proportion as an immature acre. I think it will be conceded that the tappable areas and the new clearings demand more supervision than the immature area, and should therefore carry a larger percentage of General Charges. The method employed to meet this is what might be called the unit basis of apportionment, as follows :—

1 acre mature = 1 unit.
1 ,, immature = ½ ,,
1 ,, new clearing = 1 ,,

To take a concrete example, an estate with

100 acres new clearings.
200 ,, immature rubber.
300 ,, mature ,,

the allocation would be 40 per cent. to Capital and 60 per cent. to Revenue, not 50 per cent. to each. It may be that in some instances this method may bear a little hardly on Revenue, but

should such be the case it is an error in the direction of greater safety.

The last contested point before we reach f.o.b. cost is the important item of depreciation of buildings and machinery. Provision for depreciation, if limited to the amount necessary to writing off the cost of buildings and machinery within the period of their effective working life is an essential item of F.O.B. cost. But any provision for depreciation beyond this is an appropriation of profits, and not an item of costs. The method by which depreciation is calculated is what is known amongst accountants as the straight-line method—*i.e.*, the building or machine is written off over its estimated life by equal annual instalments as far as that is possible. Repairs are charged to Revenue, renewals to Capital. Slight adjustments are sometimes necessary, owing to the expected life being shortened or prolonged, but experience usually enables a fairly close estimate to be made. This has the result, on a fully equipped estate, of almost equalising the total charge against the profits of different years, but the charge per pound of rubber varies almost directly with the output per annum.

We have still some important expenses to add before arriving at our " all-in " cost. The first is freight, landing and selling charges. Many rubber growers deduct these from the sale price of their rubber, but these items are elements of cost from the point of view that without such expense the product could not be sold and the profits could not be earned. Moreover, the general mental attitude of consumers, investors, and such-like interested in the rubber industry is that rubber is sold at a certain (or uncertain) market price, and against that market price is placed " all-in " cost. It is well to recognise that attitude and to resist any temptation there may be to water down " all-in " cost. To freight and selling charges we have to add also Head Office Administration Expenses. The question as to whether the latter should be allocated as between Capital and Revenue in respect of properties that are partly mature or immature may fairly be decided by the safe rule that no charge should be made to Capital for administration expenses which would have been equally incurred if there had been no such immature area and would in that case have been charged to Revenue. With an inclusion of all these items we have at last arrived at " all-in " cost per lb., made up as follows :—

Estate Expenditure.

(1) General Charges.
(2) Repairs to Estate Equipment.
(3) Cultivation of Mature Area.
(4) Collection and Manufacture.
(5) Local Transport and Duty.
(6) Depreciation.

= F.O.B. cost plus Freight and Selling expenses plus London Administration = " All-in " cost.

It is unquestionable that the determination of costs involves not merely questions of facts, but also matter of opinion; and if any

SHEET No. 1.

Clerical Accuracy Checked by	
Date forwarded to Agents	
Date forwarded to London	
Date received in London	
Date Summarised	

*Name of Company*_____ (_____ *Division*)

MONTHLY ESTATE REPORT ACCOUNT

for_____ 19__

being_____ Month of

FINANCIAL YEAR ending_____ 19__

MANAGER'S CERTIFICATE.

I hereby Certify that the Expenditure, as shewn in the accompanying Account Statements, has been examined and approved by me, and that the information set out in the several Statements is in accordance with the records on the Estate, and is, to the best of my knowledge and belief, correct. I further certify that all subsidiary books, including Check Roll, are in correct order and up-to-date.

*Date*_____ *19*__ _____ *Manager.*

MANAGER'S REMARKS.

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SHEET No. 2.

Company _____ Division _____

Estate Report Account for _____ 19___

DETAIL EXPENDITURE.

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Analysis No.	PARTICULARS OF EXPENDITURE.	$	c.	$	c.	Check Roll Analysis. Analysis No.	Coolies.	$	c.

SHEET No. 3.

Company Division

Estate Report Account for 19 GENERAL CHARGES EXPENDITURE.

COPYRIGHT.—GUTHRIE & Co., LIMITED, 5, Whittington Avenue, London, E.C.

Analysis No.	ANALYSIS OF EXPENDITURE.	This Month. $ c.	Previously. ____ Months. $ c.	To Date. ____ Months. $ c.	Estimates for Year. $ c.
1	Salaries				
2	Allowances				
3	Contingencies				
4	Medical				
5	Upkeep of Live and Rolling Stock				
6	General Transport				
7	Office Expenses				
8	Watchmen, Gardeners and Sweepers				
9	Agency Fees				
10	Recruiting				
11	Tamil Assessment				
12	Fire Insurance				
13	Quit Rent				
14	Visiting Agents				
15	Audit Fees				
16	School				
17	Passage Money				
18	Water Supply				
19					
20					
21					
	TOTAL "GENERAL CHARGES"				
	Apportioned as follows—				
	To Revenue Account ..... %				
	To Capital Account ..... %				
	and carried to Sheets Nos. 4 & 5.				
	REPAIRS TO ESTATE EQUIPMENT—				
22	Bungalows				
23	Lines				
24	Factory				
25	Machinery				
26	Sundry Buildings				
27	Hospital				
28	Furniture				
	TOTAL "REPAIRS TO EQUIPMENT" carried to Sheet No. 4.				

SHEET No. 4.

Company..... Division .....

Estate Report Account for..... 19.... REVENUE ACCOUNT EXPENDITURE.

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Analysis No.	ANALYSIS OF EXPENDITURE.	This Month. ... lbs.		Cost per lb This Month	Previously ... Months. ... lbs.		To Date. ... Months. ... lbs.		Cost per lb. To Date.	Estimates for Year. ... lbs.		Cost per lb. Estimates.
		$	c.		$	c.	$	c.		$	c.	
	GENERAL CHARGES ____% of $____ as per Sheet No. 3											
	REPAIRS TO ESTATE EQUIPMENT.— as per Sheet No 3											
	CULTIVATION MATURE AREA ____ acres—											
29	Weeding											
30	Lallang (Special work)											
31	Supplying											
32	Pests and Diseases											
33	Digging Over											
34	Thinning Out											
35	Tools and Implements (Usage)											
36	Upkeep of Roads and Drains											
37	New Roads and Drains											
38												
39												
40												
	TOTAL "CULTIVATION MATURE AREA"											
	COLLECTION AND MANUFACTURE—											
41	Tapping Labour											
42	Tapping Tools											
43	Marking and Numbering											
44	Factory Working Costs (Curing)											
45	Packing											
46	Carriage and Shipping											
47	Duty											
48	Store Watchmen											
49	Sundries											
	TOTAL "COLLECTION AND MANUFACTURE"											
	TOTAL "REVENUE EXPENDITURE"											
	TOTAL EXPENDITURE—											
	On Revenue Account, as above											
	On Capital Account, as per Sheet No. 5											

Company..... Division..... SHEET No. 5.

Estate Report Account for.....19..... CAPITAL ACCOUNT EXPENDITURE.

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Analysis No.	ANALYSIS OF EXPENDITURE	This Month. $ c.	Cost per acre. This Month.	Previously ....Months. $ c.	To Date. ....Months. $ c.	Cost per acre. To Date.	Estimates for Year. $ c.	Cost per acre. Estimates.
	GENERAL CHARGES..... % of $ ..... as per Sheet No. 3							
	CULTIVATION IMMATURE AREA..... acres.							
50	Weeding							
51	Lallang (Special work)							
52	Supplying							
53	Pests and Diseases							
54	Digging Over							
55	Thinning Out							
56	Tools and Implements (Usage)							
57	Upkeep of Roads and Drains							
58	New Roads and Drains							
59								
60								
	TOTAL "IMMATURE AREA"		$			$		$
	NEW CLEARINGS..... acres.							
61	Felling and Clearing							
62	Lining, Holing, Planting							
63	Seeds and Stumps used							
64	Weeding							
65	Supplying							
66	Temporary Buildings, &c.							
67								
68								
	TOTAL "NEW CLEARINGS"							
	ESTATE EQUIPMENT—							
69	Bungalows							
70	Furniture							
71	Lines							
72	Factory							
73	Machinery							
74	Sundry Buildings							
75	Hospitals							
76	Wells and Water Supply							
77								
78								
79								
	TOTAL "ESTATE EQUIPMENT"							
	TOTAL CAPITAL EXPENDITURE							

SHEET No. 6.

Company _____ Division _____

Estate Report Account for _____ *19*___ **STATISTICAL INFORMATION.**

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TREES TAPPED—STATEMENT No. 1.

Trees Tapped ..... _____trees.

Tappable Trees, resting, etc. ..... _____trees.

Total Tappable Trees ..... _____trees.

DRY RUBBER HARVESTED—STATEMENT No. 2.

PERIOD.	First Latex.	Washings and Tree Scrap.	Bark Scrap.	TOTAL.	Estimate for the year.
	lbs.	lbs.	lbs.	lbs.	
This Month					
Previously					lbs.
To Date					

RAINFALL STATEMENT—No. 3.

	inches.
This Month ..	
Previously ...	
To Date ...	

RUBBER STOCK ACCOUNT—STATEMENT No. 4.

	lbs.		lbs.
In Store, brought forward from previous Account—		Shipped this Month as per Inv. No. / No. of Cases. / Net Wt. / A/c Crop Month.	
A/ct Crop Month of _____		of _____	
_____		_____	
_____		_____	
_____		_____	
Harvested, this month as per Statement No. 2		In Store, carried forward to next Account—	
		A/ct Crop Month of _____	
		_____	
		_____	

WEEDING COSTS—STATEMENT No. 5.

	COST PER ACRE. This Month	To Date.	Estimate.
Mature Area..... acrs.			
Immature..... ..... ,,			
Total Planted..... ,,			

PLANTING SCHEDULE—STATEMENT No. 6.

	Acres.	Trees.
1906 and earlier		
1907		
1908		
1909		
1910		
1911		
1912		
1913		
1914		
1915		
1916		
1917		
1918		
1919		
1920		
1921		
Total Planted Area		
Swamps, etc.		
Reserve Planting Area		
Total Grant Area		

CHECK ROLL LABOUR FORCE—STATEMENT No. 7.

	Tamils.	Chinese.	Javanese.	Malay.	TOTAL
Men ...					
Women ...					
Boys & Girls					
TOTAL ...					

TAMIL COOLIES—STATEMENT No. 8.

As per previous Month	
Arrived this Month :—	
From Coast	
Engaged Locally	
Less Deaths	
Paid off	
Absconded	
Balance	

CATTLE—STATEMENT No. 9.

From previous Month	
Increase by Births	
,, Purchases	
Decrease by Deaths	
,, ,, Sales	
Balance	

COOLIE ADVANCE ACCOUNT—STATEMENT No. 10.

Balance previous Month		Recovered this Month	
Advances, this Month		Balance to next Month	

RICE ACCOUNT—STATEMENT No. 11.

	Bags.	Gantangs.		Bags.	Gantangs.
Balance			Issued		
Received			Balance to next Month		
			Loss in Weight=....%		

SHEET No. 7.

Company_____ Division_____

*Estate Report Account for*_____ 19__ BALANCE STATEMENTS.

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HEAD OFFICE ACCOUNT.

Dr.	$	Cts.	Cr.	$	Cts.
Balance from previous Month			Balance from previous Month		
			Remittance from London £_____ @		
			Bills Drawn against Shipments		
			Proceeds Rubber Sold in East (Enter Invoice No. and Weight)		

BALANCE SHEET.

Liabilities.	$	Cts.	Assets.	$	Cts.

large body of rubber producers could agree on the debatable points, to some of which I have alluded briefly, we should arrive at a common formula for calculating " all-in " cost which would greatly facilitate the comparison of costs between various estates or countries or districts to the general advantage of the industry. Assuming for a moment we were so agreed, the simple formula for calculating " all-in " cost would be as follows :—

$$\frac{\text{Direct charges + Proportion of General Charges + Depreciation + Freight, Selling, and London Administration.}}{\text{No. of lbs. produced}} = \text{" All-in " cost of production per lb.}$$

Until producers are so agreed a comparison of costs as between companies or estates must be misleading unless made by competent authorities who have intimate inside knowledge of the manner by which such costs are calculated. It is a common experience of many of us in the industry to listen to a comparison of costs which are in no sense comparable.

There is one element in cost of production which I have not included in the catalogue of items which have been placed before you. It is well known generally that the age of a rubber tree has an influence on its productive capacity. Generally speaking, the rubber tree gives increasing yields up to a stage in its history, and after continuing at its maximum for a time, the yield begins to diminish. If this diminution in yield continues progressively as years go on, it is inevitable that a stage is reached when the expense involved in collecting and preparing the diminishing production no longer proves economical. The plantation industry having such a short history behind it, and the treatment of the rubber tree having varied as to the system of tapping and the method of cultivation, it is impossible to say with certainty how long will be the period during which it will continue its yield up to the capacity which will justify its existence as a profit-earning unit. That being so, we have no reliable data upon which one can base or calculate a specific provision for depreciation. I have seen many calculations made by well-informed persons, but the fact that their provision varies to a very considerable degree indicates how conjectural the matter is. One authority estimated that provision to the extent of ¼d. to ½d. per lb. of rubber was necessary for amortisation of estates. Another puts it at 1.25d. per lb., and still another as high as 2d. per lb. It is well known that, for the purposes of taxation, the Dutch Government allow a deduction of 2 per cent. of the cost of the estate, which would be equivalent, on full production on an average plantation, to four-fifths of a penny per lb. But if there be a variety of opinion on its extent, there is a well-founded belief that some degree of

depreciation does take place, and forms a part of the cost of production. Some properties have made specific provision according to their own views, but the greater number have made indirect provision by financing out of revenue extension of their cultivated area, or acquisition of additional areas already planted, and in that respect have followed closely the practice of oil-producing companies.

Those who have any slight knowledge of rubber producing will appreciate that expenditure alone does not entirely determine cost per lb. Output per acre is the other factor which must receive consideration. A lesser cost per lb. does not necessarily connote a lower expenditure of money. Output can be influenced by the judgment exercised in the selection of methods of cultivation and systems of tapping, and the manner in which they may be applied; but there are conditions beyond human control—such as soil, climate, geographical position—affecting outputs. For that reason alone, there will always be a disparity in cost as between one estate or district and another estate or district. In that respect and in others, an agricultural undertaking such as rubber differs almost fundamentally from industrial enterprises, and any attempts to rigidly apply to our problems the reasoning and experience gained from manufacturing industries would only lead to false conclusions. I hope that the plea that I have entered for the adoption of a common formula for calculating costs does not suggest that I am unmindful of the fact that there can be no common formula for the treatment of rubber estates scattered over wide areas and grown under diverse conditions.

To have dealt adequately with my subject would have made too great a strain upon your patience. There are problems involved, any one of which in itself might have furnished material for a paper such as this, but I hope I have succeeded in giving a true picture of the methods employed in arriving at cost.

In conclusion, may I say just a word on a subject which has some relevancy to present-day problems—that is, the manner by which costs may be reduced under severe economic pressure. On an estate under wise and prudent direction and management every effort would be made to take the long view, and to carry on at a minimum of expense a proper programme of cultivation works as well as the works directly and immediately necessary for the production of rubber; but if the price obtainable for our product was kept for any lengthy period below an economical level, and resources consequently depleted, rubber would for a time—and in many cases for a considerable time—be produced at a low level by drastically reducing and in some cases eliminating expenditure on certain items. If you will glance at the Estate Report Account you will see the items which comprise " Repairs to Estate Equip-

ment." Expenditure of that nature might be suspended, but it would be to the detriment of such fixed assets. The numerous works which come under cultivation might be stopped temporarily. But such methods would inevitably and rapidly reduce the value of any rubber property and permanently impair its productive capacity, bringing heavy loss to its owners and creating a problem of short supplies for the consumer.

DISCUSSION.

The CHAIRMAN: This has been an extremely interesting paper, and as a person who has considerable experience of estate accounts I have listened with very close attention, and I wish to thank Mr. Hay for the trouble and pains he has been to in making these analyses for us. The sting of the paper, like the business end of a wasp, is almost at the end, which is that in getting all the costs apportioned in the proper actuarial manner there remains the unknown factor in every balance sheet presented, of knowing how far the costs incurred ought to have been incurred. The f.o.b. figure will show the cost actually in force in the period under review as deduced from actual expenditure, but whether that expenditure represents all that should have been spent the balance sheet does not tell you; and the balance sheet, or any other presentation of accounts, never can tell you whether there has been appreciation or depreciation in the capital value of a property, by neglect or otherwise. As Mr. Hay pointed out, there must always be the element of time even if we all agreed that the figures of costing should be based on an identical system.

There is one thing that I hope may come from Mr. Hay's suggestions, and that is that we may in the future have some round-table conference in which the agency group interests are represented where some mutual agreement may be come to as to what basis of apportionment should be adopted, whether the method which Mr. Hay has suggested—say, if you take the units, 1 for a mature acreage, ½ a unit for immature acreage, and 1 unit for new and developing acreage, and how these figures should be definitely arrived at. A conference which dealt with that point might result in greater uniformity. I do not suggest uniformity in accounts, but we might perhaps arrive at some uniform basis as to costs. I am quite hopeful that this subject may be further pursued and that some basis of agreement may be found between the great producing interests. It must, however, always be subject to this reservation, as Mr. Hay has pointed out in his conclusion, that unless we have each year attached to the annual accounts a true and impartial visiting agent's report which will indicate the condition of the property, balance sheets and costs must under the most perfect system of accountancy still be received with a certain amount of reserve if a correct view of the position of the company's affairs is to be arrived at.

On behalf of the Congress I want to thank Mr. Hay for the valuable paper he has given us. I should be glad to hear any remarks from other members of the Congress upon it.

Mr. CYRIL BAXENDALE: In supporting with very much pleasure your vote of thanks I would like to accept your proposal

and thrash out one or two of those points that are not altogether clear in my mind. I realise that I am breaking into ground where perhaps I should fear to tread by entering into accountancy matters, as I have no experience other than that of an estate manager and an ordinary director of planting companies. I am really, though, very interested in this subject, and I introduced it to the Conference of 1914, and I may say I had an audience that was more worthy of the present occasion, when we have a real accountant speaking to us, than the audience we have this afternoon. But I am still hoping that the results that may come from a revival of the subject may be greater than I was able to achieve.

For instance, my Chairman, who is no longer with us, did not consider that a standardised form of accounts was desirable. He thought it would be regarded as rather an impertinence to suggest that a standardised form should be set up. I, of course, totally disagreed with him, as I am sure Mr. Hay does, and I think you, Mr. Chairman, from what you have said, would also have disagreed, because the standardisation of accounts, if accepted by an international conference with good representation, or such a body as the Rubber Growers' Association, would be very helpful to the community at large without being regarded as a deed of compulsion for those who did not wish to adopt it. But it would be very useful, I am sure, to many of us, when at our board meetings we were discussing matters with our secretaries, if we could ask what was the verdict of an established accountancy committee on the subject, an international body or a Rubber Growers' Association body formed to deal with accounts.

Before I proceed with a few details I would like to say I think it would be an extremely good plan if a sub-committee were to consider this question, a committee nominated by the Rubber Growers' Association, with, I suggest, one or two practical planters as members who would perhaps advise the accountants on matters of estate detail. We do not always see exactly eye to eye, and there are many little points and questions I may myself be able just now to suggest to Mr. Hay which perhaps he has not thought of. I am going to see now if I can do so.

I take this official summary of his paper. It says: "In regard to the apportionment of indirect expenditure, or 'general charges,' upon which there is a diversity of methods and opinions, the writer says that the two methods most commonly in use are (1) apportionment on basis of wages, and (2) apportionment on basis of acreage, and expresses the opinion that while neither method is strictly scientific the second course provides the sounder basis, as many items included in 'general charges' have little or no relation to wages at all." Now, it seems to me that the concluding sentence in that paragraph, which I am just going to read, supports the first suggestion that Mr. Hay does not favour. It reads: "But 'general charges' should not be divided on the assumption that a mature acre carries the same proportion as an

immature acre, because the latter demands less supervision; and a unit basis of apportionment as a method of dealing with this is explained."

You get your result, then, by your labour rather than by your acreage. I admit he continued to explain, but reading it like that it seems to me rather to argue that the first method of apportionment is best; that is, based on wages. I may say I adopted that myself. A good many of us have other products on estates besides rubber; you might have a field of cocoanuts not costing anything like as much as a field of rubber, or you might have some other product. Therefore it seems to me the basis should be that of labour, particularly on estates with mixed products.

As regards apportioning costs either on a labour basis or on an acreage basis, I take it Mr. Hay would not recommend a monthly alteration in the figures but that he would base it on last year's results? He would take it over a considerable period? He would not suggest that every month the planter should revise his percentage?

I want to ask this question. It has often vexed my mind very considerably, and I am only asking with a wish to learn. Why should renewals of machinery come out of capital? Is that a general principle, and does it apply if the original machinery bought has not already been written off?

As regards depreciation and amortisation, I just made a rough calculation here. Assuming 7,000 lbs. of rubber is the output of an acre during its whole tappable life, assuming a tappable life of 20 years and an output of 350 lbs. an acre. Now, of course we all believe that rubber will yield profitably for more than 20 years. Assuming we start tapping with the tree at 6 years old, it brings our rubber to rather more, I should say, than to 26 years of age, allowing for resting periods, so that we get to 30 years at the very least that that 20 years of full tapping would cover. It brings our trees to, say, 30 years of age. There is practically no area in the Federated Malay States at the present time which has been tapped for this period, and on several estates considerable areas are now being cut down and re-planted. I admit that under the more merciful methods that now prevail the tappable life of the tree will undoubtedly be prolonged, but I am dealing just with the facts as we see them now, and according to my simple calculation an acre producing 350 lbs. a year for 20 years would yield a total of 7,000 lbs., and that at 2d. per lb. comes to £58. Now, the capital value of rubber throughout the Federated Malay States, I think you will find, is well up to this average of £58. The capitalised value—let us put it that way—is certainly not below £58 on the average. Therefore we lose in capital value with every pound of rubber you take out of the tree the sum of 2d.

The CHAIRMAN: That is, if your basis is sufficient.

Mr. BAXENDALE: Yes. We do not know very much about any tapping period in excess of 30 years. Again I thank Mr.

Hay for having brought up this subject. It was my baby, which I had to abandon, and I am glad he is now nursing it; and as you, sir, are in the chair, I hope we may rely on you to deal with the matter more thoroughly in the near future than we can deal with it this afternoon.

Mr. Hay: I am much obliged to you, Mr. Chairman, and to Mr. Baxendale, for the very flattering manner in which you have referred to my paper. Mr. Baxendale is much too modest when he talks about his knowledge of accountancy. By his manner of speaking on the subject he has indicated that he has an intimate knowledge of it. As to the distribution of "general charges," I admit it is a matter of opinion. I worked out for my own satisfaction several sets of figures, on my basis and on the basis of wages, and I found in effect there was very little difference; they were practically the same. But I tried to indicate in my paper certain reasons why I preferred one method to the other.

The great thing is to get a basis which is sound. But I kept out the question of mixed products because I thought the paper was long enough already and I wanted to simplify it and make it as plain as possible. But the question of mixed plantations, of course, complicates things and may involve certain adjustments of the methods I suggested.

As to renewals of machinery. Of course, if depreciation is charged then you are entitled when you renew a building to charge against capital. You have taken out of capital so much money and charged it against revenue. When you add to your fixed assets by renewing a building you have a right to charge the cost to capital. But repairs and upkeep you debit to revenue.

The Chairman: I think Mr. Baxendale's point is this. In the event of your not having depreciated entirely year by year, writing off the entire value of that machinery, are you then entitled to put it to capital?

Mr. Hay: Your depreciation should be so adjusted that at the end of the effective life of that machine it should stand as nothing in your balance sheet.

Mr. Baxendale: Supposing you are writing off 10 per cent. annually. Supposing at the end of five years you have written off 50 per cent. But some great improvement comes in the class of machinery you are using. You replace the whole of your machinery. And you have written off 50 per cent.

Mr. Hay: Then you proceed to write off the balance as soon as it has ceased to be an effective asset. You write off the whole and charge the new thing to capital.

Then there is amortisation. It is, I agree, a matter of conjecture at present, but your calculation is quite correct. In regard to standardisation I do want it to be clearly understood that I am not recommending what is advocated from another quarter. A balance sheet in my opinion is the last thing one should attempt to standardise. A balance sheet is essentially a company's own

affair. People should be allowed to express their own opinions in their own manner.

Mr. BAXENDALE: But not Profit and Loss Account?

Mr. HAY: But that may be an expression of opinion too. What you allow for this and that—that is a matter of opinion. But as to the method of costing, that is what I should like standardised, and I think your suggestion is an excellent one, that the Rubber Growers' Association should get people together to find one system on which they could be agreed. I have tried to analyse certain costs coming from certain properties, and I find very few cases in any two groups in which it is calculated in the same manner.

Mr. BAXENDALE: Would it not be very effective if in the annual report issued to shareholders the secretaries were able to say, "These accounts have been drawn up according to the form approved by the Rubber Growers' Association"?

Mr. HAY: Yes, very.

Mr. BAXENDALE: We never know now.

Mr. HAY: I know that a suggestion for standardised accounts has been put forward in a certain quarter, but that is something entirely different to what I ventured here to recommend. I endeavoured to suggest a common formula for calculating all-in cost. But the manner and the method of preparing and presenting Balance Sheets and Profit and Loss Accounts should be left entirely to each company's or owner's judgment and discretion.

Mr. QUINCY TUCKER: My experience is that five years is all right for four-shilling rubber but it must be six years for shilling rubber. Is not that a reasonable thing? It does not pay to tap a tree at five years of age for shilling rubber.

Mr. BAXENDALE: No, it does not. It is a question whether it pays to tap any rubber at a shilling.

Mr. TUCKER: Or at 1s. 6d.? At what age would you commence to tap in the Federated Malay States when rubber was at that figure?

Mr. BAXENDALE: If in the interests of the community I should say at seven years of age, and if to please the shareholders I should say at five.

The CHAIRMAN: If nobody else has any question to put to Mr. Hay I think we will tender him our thanks in the usual way, with a round of cheers.

WORK OF THE CEYLON RUBBER RESEARCH SCHEME.

Mr. P. J. Burgess, who presided, read the following paper, prepared by the Ceylon Rubber Research Scheme :—

In 1913 a Scheme of Rubber Research was established in Ceylon by a co-operative movement embodying the Government of Ceylon, certain planting proprietors and companies, in conjunction with the Imperial Institute. At that time little accurate information was available as to the behaviour of plantation rubber in manufacturing operations; but manufacturers then stated that it was less satisfactory in factory practice than fine hard Para, owing to its much wider variation in time of cure. The operations of the Scheme were therefore directed principally to a systematic study of the effect of different methods of preparation and of other factors on the variability of the rubber. This involved a detailed examination (including vulcanisation and mechanical tests) of many series of samples, and it was arranged that this should be carried out at the Imperial Institute, where a complete rubber-testing plant was installed. It was recognised that the Institute was specially fitted to conduct the work, as it had previously devoted special attention to the investigation of rubbers from various parts of the Empire, and was in close communication with rubber manufacturers who could be consulted on the many questions which would arise.

A chemist from the staff of the Imperial Institute (Mr. L. E. Campbell, B.Sc., F.I.C.) was appointed for work in Ceylon. A comprehensive programme was drawn up, and, notwithstanding the many difficulties and interruptions occasioned by the war, considerable progress was made.

Over 500 carefully controlled samples of rubber were prepared in Ceylon for examination at the Imperial Institute. The questions investigated included: (1) The amount of variation shown by rubbers prepared by a standard method; (2) the effect of different methods of preparing the raw rubber—*e.g.*, different methods of coagulation, the addition of preservatives to the latex, the dilution of the latex before coagulation, the form of the rubber (sheet, crepe, block, etc.), various methods of drying, including smoking, the characters of moist rubber, etc.; and (3) the suitability of plantation rubber for special manufacturing purposes.[1]

Reports of the investigations, a number of which were of considerable value to the planting community, were published in Ceylon as Bulletins of the Scheme, and distributed to subscribers. A summary of the principal results obtained is given in *Bulletin* No. 29. The reports have also been reprinted in the *Bulletin* of

[1] Ebonite.

the Imperial Institute (No. 4 of 1916, No. 4, 1918, No. 1, 1920, No. 4 of 1922, and No. 2 of 1923).

In addition to preparing samples for this investigation, Mr. Campbell carried out a number of experiments with the object of ascertaining the effect of tapping systems on the physiological processes of the rubber tree.

Subsequently the Rubber Growers' Association, who had maintained an independent scheme of rubber research on Culloden Estate, Neboda, where they employed a chemist and a mycologist, suggested an amalgamation with a view to preventing overlapping and securing greater efficiency. As a result of negotiations between the two organisations, a revised scheme was approved in 1920 by the Government of Ceylon for a period of five years in the first instance. The Government undertook to contribute 50 per cent. more than the sums paid by the Rubber Growers' Association and local planting companies, whilst the Rubber Growers' Association agreed to contribute £2,000 per annum. Last year £4,500 was received from the Ceylon Government and about £1,200 from local subscribers. Local subscriptions are based on the output of rubber.[2]

Provision was made under the new Scheme for special attention to be paid in the colony to mycological and botanical problems connected with the cultivation of Hevea, and for a more detailed study of chemical problems relating to latex and the preparation of raw rubber. It was also arranged that the Imperial Institute should continue to carry out investigations of the physical and chemical properties of raw and vulcanised rubber, with a view to determining its behaviour under manufacturing conditions, and that the staff in London should also investigate other questions best dealt with in this country in communication with manufacturers.

The system previously in force, whereby the work was supervised by two committees in Ceylon and London working in close co-operation, has been continued.

Investigations in Ceylon are controlled by an executive committee appointed by the Government. This committee, which is under the Chairmanship of the Director of Agriculture, contains representatives of the Government, the Rubber Growers' Association, and other subscribers. A Technical Committee, consisting of the technical staff of the Scheme and certain officers of the Department of Agriculture, considers in the first instance technical reports, schemes of work, and suggestions relating to research, and ensures close collaboration between the scientific officers.

The London Advisory Committee, which, in addition to supervising the arrangements for carrying out the work at the Imperial Institute, considers various questions referred from Ceylon,[3] is composed of representatives of the Rubber Growers' Association,

[2] The scale is the same as that of the Rubber Growers' Association—namely, £10 10s. for estates producing no rubber, together with an additional £5 5s. for every 100,000 pounds output.

[3] Also selection of staff and purchase of apparatus.

Ceylon planting interests, rubber manufacturers in this country, and other experts. In order to facilitate co-operation with the Research Association of British Rubber and Tyre Manufacturers, which deals chiefly with questions relating to the technical processes of manufacture, a representative of the Association has been included. A Technical Sub-Committee considers reports of the work carried out at the Imperial Institute and other technical matters, including the periodical reports of the technical officers in Ceylon. Minutes of the meetings in London and Ceylon are exchanged, with a view to keeping the committees in touch. An arrangement which has been made for members of the Ceylon Committee to attend the meetings of the London Committee whilst in England has proved to be of considerable assistance in this connection.

A list of members of the committees during 1923 is given in the Appendix.

In view of the widening of the scope of the operations, it was necessary to enlarge the staff both in Ceylon and London.

The Scheme provided for the appointment of a Chemist, Mycologist, Physiological Botanist, and a Secretary and Travelling Inspector in Ceylon. The officers previously engaged on rubber research in the colony were not available, and, owing to the great scarcity of suitably qualified men, much difficulty was experienced in filling the posts, and the full staff was not secured until the latter part of 1922. A list of the staff is given in the Appendix.

On the appointment of a full-time Secretary and Travelling Inspector, the offices of the Scheme were transferred from Colombo to the headquarters of the Department of Agriculture at Peradeniya, arrangements being made for periodical attendances by the Secretary at Colombo in order to deal with inquiries by subscribers.

After careful consideration, it was decided that it would be preferable for research by the Technical Officers to be carried out in the rubber-growing districts, close association with the Senior Officers of the Department of Agriculture being maintained through the Technical Committee supervising the investigations and programmes of work.

The establishment on Culloden Estate, which was handed over to the Scheme by the Rubber Growers' Association, was adopted as the nucleus of a research station, but the accommodation was found to be inadequate for the requirements of the enlarged staff. A fully equipped chemical, mycological, and botanical laboratory has, however, recently been erected, and two additional bungalows are being built. It should thus be possible for rubber research in the colony to be carried out under satisfactory conditions.

Notwithstanding the limited facilities hitherto available, a considerable amount of useful work has been accomplished in the investigation of a number of problems of immediate practical

importance to the planting community. The Chemist has been largely occupied with problems connected with the preservation of latex and the prevention of rust and mould in sheet rubber. An experimental smoke-house has been erected, and an extensive series of experiments on the smoking of rubber is in progress. The Mycologist has paid special attention to leaf-fall and pod disease, and the connection between this disease and bark rot, whilst the Physiological Botanist has undertaken a comprehensive study of brown bast.

The Chemist and Physiological Botanist have visited Java and the Federated Malay States for a period of study of the methods adopted in those countries in their particular sphere of work. Arrangements were also made by the Committee in Ceylon for a member of the staff of the Department of Agriculture to receive training in Java in the budding and grafting of rubber. On his return he gave demonstrations on estates of the methods practised in Java. Considerable interest was taken in the subject, and a prize was awarded by the Committee for the highest number of budded rubber plants.

The itinerary work of inspection is carried out by the Secretary and Travelling Inspector, whose visits to the estates are principally concerned with questions relating to the methods of dealing with diseases and the preparation of rubber, and the previous experience of this officer in Malaya in mycological and other problems connected with rubber has proved to be of considerable value in this branch of the work. In every case a full report is submitted to the agent and the estate superintendent.

The Technical Staff in London has been enlarged, and now consists of a Superintendent (with manufacturing experience), two assistant chemists, and a mechanic.

The principal investigation in progress is a continuation of the study of the variability of plantation rubber, which was commenced under the previous scheme. A number of the problems dealt with require further detailed study, and for this purpose a comparative examination is being made of particular forms of rubber prepared under standard conditions on different estates at different periods throughout the year.

In addition to the examination of samples prepared in Ceylon at the request of the London Committee for this and other investigations, tests are carried out on samples forwarded in connection with experiments initiated by the staff in the colony (*e.g.*, preservation of latex), and, as was the case under the previous scheme, a considerable amount of work is being done on the examination of rubbers prepared by new processes.[4]

The Technical Sub-Committee have for some time devoted particular attention to the testing of rubber. The methods adopted

4 Davidson, Kilmold, Hopkinson processes, sodium silico-fluoride as coagulant.

at the Imperial Institute were carefully reviewed on completion of the examination of the samples prepared under the previous scheme, and it was decided that the tests should be modified and extended. In addition to the tests in a rubber-sulphur mixing generally adopted, the new series of samples are being submitted to examination in a mineral mixing, in order to obtain fuller information as to the results obtainable under manufacturing conditions. The possibility of including experiments by comparing the behaviour of rubbers during the various processes of manufacture[5] is under consideration.

As a result of a discussion with the Director of the Research Association of British Rubber and Tyre Manufacturers, a number of special tests are being made to investigate the statement of the manufacturers that plantation rubber is still not so suitable as fine hard Para rubber for a few of their purposes. The effect of different conditions of testing is being studied in conjunction with the Central Rubber Station in Java; the Committee are also in communication with the Rubber Division of the American Chemical Society regarding the testing of rubber, and it is hoped ultimately to arrange for more uniform methods to be adopted by rubber investigators.

Special provision has been made by the Committee in Ceylon for keeping subscribers in touch with the progress of the work. An annual general meeting is held in the Colony, at which detailed reports by the London and Ceylon Committees and by the Technical Staff are submitted. In addition, bulletins containing reports on the investigations in London and Ceylon are circulated, and also quarterly circulars reviewing the work being done by the Technical Officers, and drawing attention to matters of general importance to planters. All subscribers are eligible to receive the *Bulletin* and reports on research work issued by the Rubber Growers' Association. As indicated above, adequate facilities exist for their receiving advice from the Technical Staff on matters of individual interest (*e.g.*, by inquiry at the office at Peradeniya or Colombo, or by application for a special visit by the Secretary and Travelling Inspector).

It will thus be seen that the Scheme aims at ensuring that the work is carried out not only in close association with the subscribers and the planting community, but also with manufacturers in this country and with other research organisations. Greater interest is being taken in the Scheme now that it is in full operation, and local subscriptions are increasing. Approximately 60 per cent. of the acreage under rubber is now represented, and it is hoped to secure the support of the whole rubber-planting community in Ceylon.

5 *e.g.*, mastication, extruding, adhesion.

APPENDIX.

Committees of the Ceylon Rubber Research Scheme, 1923.

Executive Committee in Ceylon.

The Hon'ble. Mr. F. A. Stockdale (Chairman).
Mr. C. W. Bickmore.
The Hon'ble. The Lt.-Col. T. Y. Wright.
Mr. M. Kelway Bamber.
Mr. T. Petch.
Mr. Clifford Figg
(during absence of Mr. F. J. Poyntz Roberts).
Mr. A. F. B. Smeaton
(during absence of Mr. J. F. Elford).
Mr. L. M. W. Wilkins.
Mr. D. Finch Noyes
(during absence of Mr. C. P. Madden).
Mr. A. C. Callender.
Mr. D. S. Cameron.
Mr. G. Bruce Foote.
Mr. F. H. Layard.
Mr. W. Coombe.
James Mitchell (Secretary).

Technical Committee in Ceylon.

The Hon'ble. Mr. F. A. Stockdale (Chairman).
Mr. T. Petch, Mycologist, Department of Agriculture.
Dr J. C. Hutson, Entomologist, Department of Agriculture.
Mr. M. Kelway Bamber, Consulting Chemist, Department of Agriculture.
Mr. G. Bryce, Assistant Mycologist, Department of Agriculture.
Mr. A. T. Reeve, Plant Pests Inspector (Southern), Department of Agriculture.
Mr. T. E. H. O'Brien, Chemist to Scheme.
Mr. M. Park, Mycologist to Scheme.
Mr. R A. Taylor, Physiological Botanist to Scheme.
J. Mitchell, Secretary and Travelling Inspector to Scheme (Secretary).

London Advisory Committee.

Representative of Imperial Institute.	Prof. Wyndham R. Dunstan, C.M.G., LL.D., F.R.S. (Chairman) (now Sir Wyndham R. Dunstan, K.C.M.G.).
Representatives of Ceylon Planting Interests.	Sir Edward Rosling. Sir Stanley Bois. Mr. G. H. Golledge.
Representatives of the Rubber Growers' Association.	Mr. H. Eric Miller. Mr. Herbert Wright. (one vacancy.)
Representatives of Rubber Manufacturing Companies.	Mr. Percy Rosling. Mr. W. A. Williams. Dr. D. F. Twiss.
Representative of the Research Association of British Rubber and Tyre Manufacturers.	Mr. A. Johnston.
Botanists.	Prof. J. B. Farmer, F.R.S. Mr. H. N. Ridley, C.M.G., F.R.S.
Secretary.	Mr. J. A. Nelson, B.Sc.

The following members formed the Technical Sub-Committee: Professor W. R. Dunston (Chairman), Sir Edward Rosling, Messrs. Johnston, Ridley, Twiss, Williams, Wright.

Scientific and Technical Staff.

Ceylon.

J. Mitchell, A.R.C.S., Secretary and Travelling Inspector.
T. E. H. O'Brien, B.Sc., Chemist.
M. Park, A.R.C.S., Mycologist.
R. A. Taylor, B.Sc., Physiological Botanist.

London.

G. Martin, B.Sc., A.I.C., Superintendent.
W. S. Davey, B.Sc., A.I.C., Chemist.
F. L. Elliott, F.I.C., Chemist.
L. L. Stewart, Laboratory Assistant.

ON THE TRAINING OF SCIENTIFIC OFFICERS FOR TROPICAL PLANTATION INDUSTRY.

By J. B. FARMER, D.Sc., LL.D., F.R.S.
Director of the Biological Laboratories, Imperial College of Science and Technology, London.

The CHAIRMAN (Mr. P. J. Burgess) read the following paper by Prof. J. B. Farmer :—

The training of a scientific officer for tropical plantation industries must necessarily vary to some extent in relation to the duties which he is ultimately to be called upon to discharge. Broadly speaking, these duties or functions resolve themselves into three classes, and the requirements of each should be met by the appointment of correspondingly different classes of officers—viz. :—

(A) Purely scientific officers, mainly engaged in research. Nearly related to these, and perhaps selected from their ranks :

(B) Men of scientific training and outlook, but whose main object is to disseminate information and to give advice by means of visits to different plantations and factories, and in various other ways.

(C) Agricultural scientific officers.

Men qualified to discharge the duties of any one of these three posts ought to have received a thoroughly scientific training at least up to the standard of a high honours degree at a University. An agricultural officer should, in addition to this, have had training in the principles of agriculture as practised in the field.

It will be convenient to consider separately the three main classes indicated above.

A. *Purely Scientific Officers.*—These will chiefly consist of chemists and biologists (including mycologists, plant physiologists, plant breeders, and entomologists).

(1) A chemist, in addition to having received a broad general scientific training, should have specialised at the close of his University career for at least a year in the particular aspects of chemistry and physics which bear upon the problems that will lie before him, and should have also had training in research. I do not mean by this that he ought to confine his attention to rubber, or to any other single tropical product. He will be continually faced by problems the solution of which will depend upon knowledge outside the range of his immediate subject, and for this reason it

is necessary for him to possess a good all-round training. Moreover, it is not even desirable that he should have devoted his earlier research experience merely to the " getting up " of the technique of such a subject as rubber. His time will have been better spent, from the point of view of the industry, in acquiring a knowledge of the methods and technique of physical and organic chemistry generally. Such training will be invaluable to him when he has to apply himself to the problems that will confront him in the laboratory and the factory. A man in a narrow groove is seldom or never an employée of the greatest value.

(2) Turning now to the biological staff, the training of these men should also, *mutatis mutandis,* be conducted on broad lines analogous to those insisted on for the chemists It is essential that, in addition to their botanical acquirements, they should have had a sound training in chemistry, not to speak of other branches of science. It may be said generally that at least from two to two and a-half years are necessary to train a man properly for economic botany or entomology *after* he has received his general scientific groundwork. The particular line on which he is destined ultimately to specialise will appear during this period of his education. Thus a plant physiologist requires a much greater knowledge of chemistry and physics than a mycologist or entomologist who, on the other hand, needs to have at his fingers' ends a much more detailed knowledge of the actual plant diseases or insect pests and the technique for isolating and experimenting with them, than does the plant physiologist, and it is seldom that aptitude for both subjects is combined in one individual. A plant breeder, whose work is of a rather special kind, ought to have had practical training at one of the institutes that concerns itself with this work, and he ought to have worked under the direction of a recognised leader in genetics.

From the point of view of usefulness to the industry, it is essential that every officer should be equipped with as wide a general knowledge as possible of the sciences bearing on his special subject, but it is important that during his course of training he should not be tied down in any way to the study of the particular kind of physiology or the kind of mycology or bacteriology which may appear most likely to be immediately useful to him on the plantation. In a word, a man's ultimate usefulness will depend more upon the *breadth of outlook* which he acquires during his period of training, rather than upon any *intensive knowledge of the problems which will confront him in the industry.* The latter knowledge will come soon enough when he gets to grips with the problems themselves, and the measure of success with which he is able to attack them will, other things being equal, chiefly depend upon the extent of general scientific knowledge which he is able to bring to bear upon them. Thus, I should entirely deprecate devoting a student's time to the study of rubber plantations problems. He will learn more about these problems, and learn it better (if his previous training has been what it ought to be), in two months on the plantations than he can possibly do in a year's work in Europe. As a student, away from actual contact with the industry, his time will be far more usefully spent in laying

a sound foundation of scientific knowledge and ideas, and of the technique and practice of research.

In addition, however, to laboratory experience, a good officer ought to have had, during his University training, some experience in the field, in order to enable him to grasp those fundamental principles which underlie so many of the reactions of plants to their environment.

For example, many problems of disease often resolve themselves into problems of nutrition, or of aeration of the soil, or of water supply, etc. When any of these conditions are defective the plant easily may—and experience shows it actually does—lose the curious quality of *resistance to infection,* and this is equally true whether one is dealing with the infection of a fungus or with the depredations of an insect pest. For example, it is known that inadequate aeration of the soil through deposit of silt, as a consequence of defective or deficient drainage, may so reduce the vitality of the plant by affecting the supply of oxygen to its roots as to render it an easy prey to the attack of pests and diseases which, under better conditions, it would successfully resist. In making these statements I am quoting from personal observation and experience, and they can easily be verified and amplified by anyone who knows how and where to look for appropriate examples.

It will be of very great advantage to a scientific officer, and still more to his employers, if, after being selected for a post but before he is sent to take up the duties attaching to it, he is afforded an opportunity of working, say for six months, at some tropical institution such as the Imperial College of Tropical Agriculture in the West Indies. There are other institutions which are also capable of affording similar advantages. The increased value of a man who has had this additional experience will be due to the circumstance that he has learnt, under skilled guidance and under specially advantageous conditions, to focus his knowledge upon tropical agriculture in the wider sense, and thus he will be enabled to short-circuit the gap between work in a European laboratory and practice in the Tropics. He will get a wider outlook on tropical problems generally, and he ought to be able thereby—and far more effectively—to concentrate on the particular ones which will face him in any individual district. I have no hesitation in saying that any expense incurred in giving an officer this additional training will be repaid to his employers many times over.

It is, of course, clearly recognised that the troubles which arise from the actual pests on the plantation are largely fungal or bacterial on the one hand, and animal—chiefly insect—on the other. But it would be unreasonable to expect that a man can qualify as a specialist fitted to be entrusted with the responsibility of serving a plantation industry in dealing with pests both of animal and of vegetable origin alike. The field of knowledge is too wide for any one man to cover. But I should like to record it as my opinion that the entomologists, like the botanist, in addition to having a sound knowledge of entomology together with the remedial measures which such knowledge indicates, should at the same time be keenly alive to the influence of agricultural conditions

upon the incidence of insect epidemics. This aspect of an entomologist's scientific training too often escapes attention.

B. When a trained scientific officer reaches the district to which he is appointed, there appear to be two main types of work which may lie in front of him—namely, either that of scientific investigation, or that of the dissemination of information by means of visits to plantations, factories, and the like. Some men have greater aptitude for one kind of work than the other, and it ought to be clearly understood that it is a waste of effort, as well as of money, to be continually asking a man whose mind is set on investigation to leave his proper work in order to take over what might be described as " missionary work." By this I do not mean that a man whose main interest lies in research should be confined to his laboratory; some practical experience, such as visits to plantations or factories can afford, he ought certainly to have. What I do mean is that to take a man of the research type and continually to be calling him off from his proper work to visit plantations for the purpose of giving advice is to misuse him, and this means a waste of money. A good investigator is not necessarily a good adviser to a planter who wants quick results, and interruption of research too often involves unnecessary postponement, or even the loss, of results of far-reaching importance to industry. Naturally, it is not possible to lay down hard-and-fast rules, but the distinction I have here drawn is a real one, and wherever possible it should be kept in mind in organising a research staff.

It is also essential that a man whose time is mainly to be spent as a scientific adviser and in disseminating information should have had a sound preliminary scientific training similar to that already laid down for the investigator, but it will be turned to a different account. His material and point of view are different. His material is the plantation itself and the men who are employed in it, and he has to study both the one and the other. At the same time, it is necessary that he should be in close touch with the sources of that new knowledge which the scientific investigators are continually acquiring. Without this, and without an adequate initial training, his work may easily be worse than useless. With it, provided he has the necessary tact and possesses practical knowledge and sense, he should form an indispenable link between the research staff and the planter. The distinction I have here attempted to draw applies, though in somewhat different degree, to other cases. Probably the entomologist, more than anyone else, can combine real research with advisory functions with least loss of general efficiency.

C. The higher agricultural officers will naturally be concerned mainly or entirely with administrative and advisory work, but in their case also a scientific foundation is absolutely essential. The kind of agriculturist who only has a " practical " knowledge of the land is not the kind of person, who in the long run, is at all likely to be of most use to the industry. There are already too many examples of mistakes in agricultural practice due to the lack of the right kind of preliminary scientific training. In a word,

the agricultural officer must have been trained in the *principles* of agricultural *science*, as well as in the *practice* of agricultural *art*.

One further general remark I should like to make in conclusion. All scientific officers tied down to their own districts tend to become out of date, or at any rate "stale," unless they are given the opportunity at fairly frequent intervals (say, every four years) of coming into personal contact with the progress of work as it is going on in leading laboratories and institutes, whether in Europe or in America. It ought to be clearly recognised that it is of the greatest advantage to every employer to see to it that the scientific staff are sent at sufficiently frequent intervals to renew their acquaintance with men working at home, and thus to have an opportunity for acquiring experience of the new knowledge which is continually being made. "Study leave," as it is often called, is a first-class investment from the employers' point of view, whether that employer be an individual, a syndicate or a Colonial Government.

SPRAYED RUBBER LATEX.

By HENRY P. STEVENS, M.A., Ph.D., F.I.C.
Consulting Chemist to the Rubber Growers' Association (Inc.).

Mr. P. J. BURGESS, who presided, said: All here know of Dr. Stevens, and you know he is an expert on the subject of rubber technology. Few are better qualified than Dr. Stevens, and we are looking forward to what he has to say about Sprayed Latex.

Dr. STEVENS: The latex of the *Hevea Braziliensis* is so readily coagulated, and the present method of preparation is so simple, that there would appear to be little need for developing other methods of rubber preparation. At the present time, the cost of converting latex into dry rubber on the plantations in the Federated Malay States is in the neighbourhood of ½d. per lb., so that alternative processes must be cheap and efficient if they are to compete with that at present in vogue.

Although the cost of manufacture is an important item, there is another factor of equal if not greater importance, namely, the quality of the product. A more expensive process should be recommended for adoption if it is certain that the quality of the rubber would be improved. I use the word quality in the larger sense to include uniformity and desirability for manufacture of rubber goods from every point of view.

I propose to describe the development of the spraying processes and the quality of the rubber produced, with a view to ascertaining whether or no spraying is to be recommended for general adoption on rubber estates.

Broadly speaking all methods of Para rubber preparation fall into one of two groups; the coagulative and the evaporative. Fine Para rubber probably combines both methods, although I am of opinion that the coagulative process predominates. A number of simple evaporative methods have been proposed, but the spraying process is the only one which has been developed on any considerable scale.

It is well known that Para rubber can be obtained by evaporation of the latex, with or without smoke, on flat surfaces, such as glass plates, or, better, on revolving drums; but even where the design of such machines has been in the hands of capable engineers it has always been found that the fuel consumption is high and the output low, and this in spite of the relatively high temperatures which have been employed. Such processes result in a soft rubber, which, as far as my experience goes, breaks down readily on the mixing rollers, but does not give vulcanisates with such high tensiles as the ordinary plantation crepe and smoked sheet. Having regard to the low output and high fuel consumption, such processes are more expensive to run than those

ordinarily in use, and as the quality shows no improvement there has been no incentive to adopt them on estates.

The properties of such rubber are of considerable interest, because they comprise almost the whole of the constituents of the latex, and may consequently be termed "whole latex rubbers." When analysed, the figures obtained differ markedly from those obtained with plantation sheet, crepe, or fine Para. I give typical analyses from various sources of the different types, with an analysis of the total solids contained in latex.

I wish particularly to draw your attention to the figures for fine Para, which closely resemble those for plantation crepe and sheet, and differ from rubber obtained by evaporative processes—that is, whole latex rubber. It is evident that in the preparation of fine Para most of the serum is lost, and drips off as the films coagulate. A little serum may still remain, as in the case of crepe and sheet rubber, absorbed or otherwise mechanically held, and part of this will be removed on the manufacturers' washing rollers in the process of crepeing. This is always necessary to obtain the rubber in a convenient condition for drying. Fine Para is, therefore, not a whole latex rubber, as is frequently stated, and the method of preparation and product more closely resemble ordinary plantation rubber than that obtained by an evaporative process, whether by spraying or any other means. Evaporative processes cannot therefore obtain support on the analogy of fine Para.

Of the types given in the analyses I would also draw your attention to the Kerbosch rubber, which has been fully investigated by Dr. de Vries. It is a typical whole-latex rubber, and the analytical figures approach closely to those of dried latex, as would be expected. The samples of sprayed rubber give similar figures.

TABLE I.

Analytical figures for various types of *hevea* rubber.

	Plantation crepe and sheet.	Washed and dried fine Para.	Total latex solids.	Kerbosch rubber.	Sprayed rubber.
Moisture	0.2 to 1.0	0.2 to 1.0	2.4 to 3.6	3 to 4 ·	0.6 to 1.0
Acetone extract ("resins") ...	1.5 ,, 3.8	3	3 ,, 4	3 ,, 4	4.7 ,, 5 2
Water extract ...	0.3 or more	0.5	5.6 ,, 5.9	5.6 ,, 6.6	7.2 ,, 9.9
Protein (nitrogen x 6.65)... ...	2.2 to 3.8	2 to 3	4.2 ,, 4.8	5.0 ,, 5.7	4.2
Ash	0.2 ,, 0.9	0.3 ·	1.4 ,, 1.8	1.5 ,, 2.0	1.5
Caoutchouc hydrocarbon (by diff.)	92.1 ,, 94.6	92.2 to 94.0	85.8 ,, 89.0	84.3 ,, 87.5	88.1 to 89.0

The above figures are taken from published analyses of different investigators. The caoutchouc hydrocarbon is determined by difference, excluding the water extract, which will consist largely of substances included under acetone extract protein and ash. The amount of water extract is dependent on the prolongation of the extraction operation. Rubber allows the water soluble substances to pass out with difficulty. Wet crepeing of sprayed rubber, or otherwise evaporated latex, removes one per cent. or less. Sprayed rubber gave a water extract when

ordinarily determined by long soaking in hot water of about 7 per cent., but by extracting for some weeks and re-crepeing from time to time to expose fresh surfaces, I obtained nearly 10 per cent. of extract. Plantation crepe rubber gives a very small extract, less than one half per cent., but smoked sheet gives an appreciably larger extract on prolonged extraction. This is due to the method of preparation, as the serum is rolled out under light pressure and the coagulum is not torn about, and rinsed under a stream of water as in crepe rubber. Similarly, fine Para gives a very low water extract. Normally, this rubber contains about 20 per cent. of moisture, but most of this is removed in the process of washing and drying. The amount of acetone extract also varies with the period of extraction.

A number of experiments have been made to ascertain the increase in weight of the rubber produced by evaporation as compared with coagulation and washing. In a series of experiments (Bulletin, Rubber Growers' Association, January, 1923, p. 42) I obtained figures for increase in weight varying from 6.8 to 14.1 per cent., using a number of preserved latices of different origins. For commercial purposes a figure of 10 per cent. may be taken as an average, and this figure is also given by Hopkinson. De Vries, who has more recently published figures obtained from fresh latices, gives the increase in weight as from 8 to 10 per cent. As noted above, however, I have actually extracted 9.9 per cent. of water-soluble material from sprayed latex rubber.

Of what do these water-soluble serum substances consist, and are they of value in the rubber when used in the manufacture of rubber goods? On these points there is a difference of opinion. No doubt the matter is best decided by the practical vulcanising tests which are given later on in this paper. It is, however, of interest to consider the matter from the more theoretical standpoint. The serum from rubber latex contains a number of substances which have not been isolated and characterised, but the main constituents consist of (1) l-methyl inositol, a white crystalline substance readily soluble in water and alcohol; (2) salts; (3) nitrogenous (protein) matter; and (4) sugars and other carbohydrates. Basing my results on analyses of three different latices (8th International Congress of Applied Chemistry, vol. 9, p. 41), the constituents are present in the serum in the following proportions :—

l-methyl inositol	58.1	per cent.
Salts	16.2	,, ,,
Protein (nitrogenous substances) ...	15.7	,, ,,
Sugars and other carbohydrates ...	10.0	,, ,,
	100.0	,, ,,

It will be seen that the inositol is by far the largest constituent, and with the salts and sugars makes up 85 per cent. of the serum. How will these constituents affect the properties of the vulcanised rubber? As far as one can anticipate from theoretical considerations, they will act merely as diluents or fillers. They will

detract from the physical properties such as the tensile strength, but may have some compensating advantages such as fillers and adulterants possess. If, however, one were given a choice, there are fillers and diluents one would prefer to use, and which can be added to rubber on the mixing mill without difficulty.

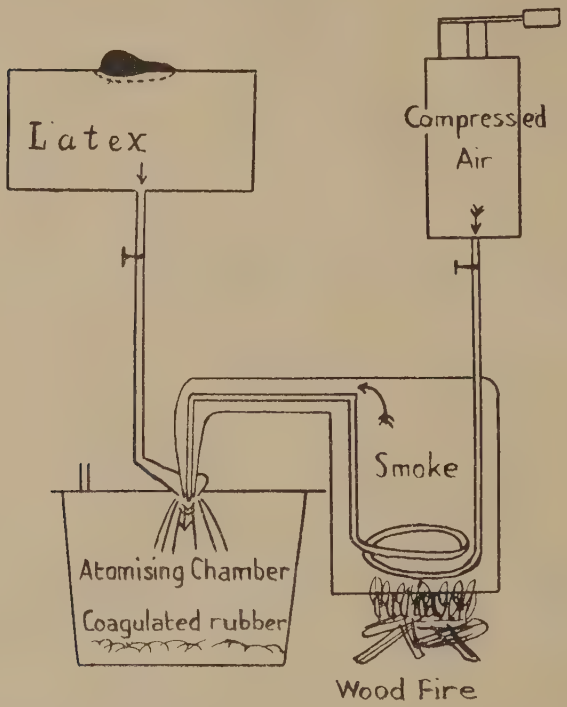
There remains the 15 per cent. of nitrogenous matter. This is known to benefit the rubber in some cases, mainly by increasing the rate of vulcanisation—that is, by shortening the cure. This result is, however, readily obtained by the use of accelerators. There are, therefore, no theoretical grounds for attributing any special virtue to the serum ingredients, only a small part of which can have any direct beneficial effect on the rubber. In any case, similar results should be obtained more readily and under better control by the addition of fillers, diluents and accelerators to ordinary plantation rubber when on the factory mixing rollers.

The introduction of spraying into hot air as a means of desiccating latex is the natural outcome of the application of a similar process to other raw materials—in particular, milk. The earlier processes for desiccating milk consisted in allowing liquid to flow on to the surface of a steam-heated drum. As this revolves the water is evaporated—preferably with the aid of a vacuum—and the dried product is removed by means of a scraper. I remember similar methods were tried with rubber latex, but the rubber deposited adhered too firmly to the drum to be readily removed. I prepared a few pounds of rubber by means of a revolving drum about 15 years ago from imported latex preserved with formaline. The method has been recently revived. The rubber in this case flows on to the outer surface of a revolving drum, into which smoke is led from a furnace. The smoke then passes on to the surface of the latex on the outer surface of the drum, and a wet coagulum is removed by a scraper. This process resembles that employed in the preparation of fine Para, in that coagulation is brought about by the smoke aided by heat, and it is particularly interesting to note that the coagulum scraped off is very wet, and exudes quantities of dark brown serum.

With the introduction of spraying processes for milk and similar organic products, experiments were naturally made with rubber latex, as this was by then available in Europe in quantity preserved with ammonia. The first reference I know of will be found in a paper by Dr. Esch, in the " Gummi Markt " for July, 1911. Although the apparatus (Fig. I.) is drawn in a sketchy manner, it embodies all the essentials of the present processes, and in addition combines a means of simultaneously smoking the rubber. At the present time there are, to my knowledge, three different spraying processes in the field. The principle in all is the same, namely, the production of a fine spray, or " atomised " latex, which meets a current of hot air moving in the opposite direction, causing desiccation of the fine drops

of latex, which collect as a sponge-like mass at the bottom of the chamber.

Figure I.



To judge from the descriptions of the processes, the main difficulty met with consists in the production of a fine spray from a nozzle which will not become clogged with coagulated rubber, and it is interesting to note that the earlier patent, taken out by American interests in the Federated Malay States, describes the use of a spraying jet, while the later patent employs a rotating disc from which the latex is thrown off. This latter method has obvious advantages, and is, I believe, an integral part of the Krause machine patents, which were first taken out about the year 1913. I do not wish to enter into a discussion of the rival claims of the various makes, and will refer you to the patent specifications for further details. I have made tests with rubber from three different sources.

Sprayed rubber, by whatever process produced, consists of a spongy mass of a dull white colour, which, when compressed, yields a mass, or block, of a dull yellow-brown to creamy-white colour, having a marbled appearance. This arises from the varying degree of compression to which the rubber is subjected.

When first produced a creamy-white, spongy product is obtained, which, after compression, gives a darker, browner and more translucent substance. The blocks are not so compact as blocks made by compressing ordinary crepe rubber, such as the well-known Lanadron block. Thus, the specific gravity of the sprayed rubber block I found to be 0.908, whereas a block from compressed crepe has a specific gravity of 0.920.

The rubber swells, but does not readily dissolve in solvents such as benzine. The swollen mass breaks down very slowly; more slowly than in smoked sheet.

The sprayed rubber block is easily cut with a wet knife, more easily than ordinary prepared rubber. It feels softer and more yielding. This may be a property of the rubber itself caused by the 10 per cent. of water soluble constituents retained, or may be partly accounted for by the porosity and air enclosed, as indicated by the lower specific gravity. Thus, the hardness, or resistance to penetration, of a normal sample of smoked sheet rubber gives a figure of 43 on an arbitrary scale, while the darker parts of the sprayed rubber block give the figure of 34, and the lighter parts 24. The lighter parts will retain more air, and will, therefore, be more spongy and less resistant to penetration. Except for the variation in density the rubber appears homogeneous and uniform. A thin strip stretched between the fingers to the limit of extension returns immediately to its original length, and generally shows hysteresis to a lesser extent than ordinary sheet rubber. Freshly-cut surfaces adhere when pressed together, but not very readily. The physical properties of the sprayed rubber do not indicate any decomposition or deterioration brought about by the method of manufacture, in spite of the relatively high temperature to which the latex is exposed in process of evaporation. The rubber is more difficult to break down than average sheet or crepe, and when broken down and milled, is less plastic and more difficult to sheet. Irregularities and markings on a calendered sheet are difficult to remove during vulcanising, and greater pressure is required than with ordinary sheet and crepe. Thus, taking the case of a "plain" rubber-sulphur mixture. When this is wrapped round a tube and tied up with cloth, as in the manufacture of tubes for cutting washers, elastic bands and similar goods, the join, or overlap, completely disappears with ordinarily prepared rubber; but, with sprayed rubber, the outer joint where the rubber overlaps is still visible after vulcanising. In some cases, the inner overlap left a distinct crease, or seam, down the inside of the tube. With ordinary milled rubber, the joint is entirely obliterated by the pressure exerted by the cloth during vulcanising.

As regards the difficulty with which sprayed rubber is broken down, the following experiment may be quoted: 22 lbs. were broken down and milled on a small factory machine. Altogether, 1¼ hours were required, whereas a similar batch of plantation was broken down in about 20 minutes. In the case of the sprayed rubber, part of the time taken was occupied in replacing the motor fuses, which blew twice during the operation. From

this it is evident that the power required for breaking down the sprayed rubber is considerably more than for ordinary crepe rubber. The electric units consumed were noted—sprayed rubber took 9 units, where the ordinary plantation crepe required 4 to 5 units, so that the sprayed rubber required approximately twice as much power to break down and mill as average pale crepe. In this connection it should be noted that Hopkinson agrees that sprayed rubber is more difficult to break down, but puts the extra time and power each at only 15 per cent. above the figures for plantation rubber. But, apart from the additional time required, the milled rubber is less plastic than ordinary plantation. I have not, as yet, had the opportunity of experimenting with this rubber in tubing machines, but I should anticipate some difficulty in spewing as greater power would be required.

The milled rubber behaves in the normal manner during mixing, but the powders show a greater tendency to caking, and, under certain circumstances, adhesion of the stock to the back roller. These defects are, no doubt, attributable to the excess of serum constituents in the rubber, which must tend to alter the character of the material just as would be the case if 10 per cent. of other non-rubber ingredients of a similar nature were added. If the serum constituents be recovered from the serum from sheet or crepe manufacture and concentrated on the water bath, a dark brown, sticky mass is obtained, and such an ingredient of a rubber mixing would be expected to produce caking of the powders and adhesion to the back roller.

The vulcanisation of sprayed rubber calls for no particular comment, except in regard to rate of cure. All samples of sprayed rubber I have examined vulcanise appreciably faster than ordinary sheet and crepe, whether mould or open steam cured. The results recorded in this paper were obtained with open steam-cured mixes. In the preparation of sprayed rubber, it is recommended to add a small quantity of ammonia to the latex, which acts as a stabiliser and keeps the latex in good condition when stored previous to use. When the spraying operation is carried out in the country where the latex is produced, the proportion of ammonia required is very small—Hopkinson says 0.1 per cent.—as the latex is used within a short time of collection. If, however, the latex is brought to Europe or America for spraying, the proportion of ammonia required is higher—say, ½ to 1 per cent. —and this has some effect on the latex and quality of the rubber produced. The latex loses in viscosity, shows a tendency to cream, and is more difficult to coagulate with acids. The rubber produced by coagulation and washing, as in the preparation of crepe from ammonia-preserved latex, vulcanises faster than that prepared from fresh latex. It may, therefore, be that increased rate of vulcanising shown by sprayed rubber is partly due to the fact that the latex used in making this rubber is preserved with ammonia.

Thus, taking the average time of vulcanisation of an ordinary plantation rubber, under certain specified conditions, as 180 minutes, it is found that crepe rubber prepared from ammonia-

preserved latex vulcanises to the same degree in 137 minutes, and sprayed rubber, under similar conditions, in 108 minutes, or, putting the rate of vulcanisation of standard plantation crepe =100 per cent., we have crepe prepared from ammonia-preserved latex=132 per cent., and sprayed rubber=167 per cent. It is probable that the ammonia either favours the formation of, or actually produces, accelerating substances in the latex, as the same effect is not obtained with other alkaline preservatives, such as caustic soda. A series of experiments with caustic soda-preserved latex shows these to yield a crepe which vulcanises at a normal rate, or slower than normal. I am here referring to the ordinary " pure " rubber test mixing, consisting of 90 parts rubber with 10 parts sulphur and no other ingredient. When accelerators, mineral or organic, are introduced, the differences noted in rate of cure are diminished, or may totally disappear. A very similar figure for rate of vulcanisation is given by other varieties of sprayed rubber, but an exact comparison is difficult, in that the physical properties, particularly the elongation at a given load, do not correspond to the same " state of cure " as with ordinary plantation and fine Para. With the latter the maximal tensiles are obtained with a state of cure for a standard curve giving an elongation of 850 per cent. with a load of 130 kilos. per sq. cm. But if sprayed rubber is vulcanised to give this standard curve, the product is brittle and seldom gives satisfactory figures. It is, in fact, over-cured, from the optimum cure standpoint, and, of course, grossly over-cured from the technical standpoint. This makes a direct comparison on the usual testing standards impossible, and necessitates a number of test vulcanisations to ascertain the optimum conditions of cure. The best results are obtained with cures of 80 to 90 minutes (under my standard conditions of vulcanising), as against 140 to 190 minutes required to give the standard curve. And in place of an elongation of 850 per cent., there is found to be an elongation of 920 per cent., or more, under a load of 130 kilos. per sq. cm. The actual figures for tensile strength obtained with sprayed rubber are always lower than those obtainable with good quality plantation sheet and crepe. Whereas the latter gives maximal breaking loads up to 150 or 160 kilos. per sq. cm. under my conditions of testing, the highest figures obtainable with sprayed rubber are, approximately, 140 to 150 kilos. per sq. cm. With later bulk quantities of sprayed rubber the figures have been lower still, varying from 120 to 140 kilos. per sq. cm. The final length obtained with the rubber giving its maximal tensile strength was, approximately, 1,000 per cent., and the elongation at a load of 130 kilos. approximately 910 per cent. This latter figure is comparable with 850 per cent. usual with plantation crepe rubber. According to the patent specification and to some recently published results (" India Rubber Journal "), much higher tensile figures are obtainable with sprayed rubber. Thus, the average

tensile strengths of 30 different lots are given approximately as follows :—

Sprayed rubber	250 kilos. per sq. cm.
Plantation crepe and smoked sheet ...	227 ,, ,, ,, ,,
Fine Para	213 ,, ,, ,, ,,

The machine used and details of tests are not given, but all these figures look extraordinarily high. They have the appearance of proving too much, for, if sprayed rubber is superior to other types, plantation rubber, as ordinarily prepared, is superior to fine Para. In the same publication (" India Rubber Journal," December 29th, 1923, p. 10) are given the tensile strength, time of vulcanisation curves of a large number of specimens of sprayed rubber, also of plantation sheet and crepe. In the latter, variations in maximal tensiles are given, varying from, approximately, 180 to 260 kilos. per sq. cm. These figures may be compared with de Vries' results, obtained from 1,415 samples from the output of a large number of estates (" Estate Rubber," p. 467). Taking sheet rubber, de Vries' figures (mould-cured test pieces) varied from 125 to 155 kilos., the great majority lying between the limits of 130 and 150. My own figures are of a similar order, although my method of vulcanising is somewhat different. Of course, if one takes any sample of sheet or crepe obtainable on the market, irrespective of origin, much wider variations are obtainable; thus, with lower grades, de Vries obtained figures from under 100 to over 150 kilos. per sq. cm. With sprayed rubber the figures quoted vary from 230 to 280 kilos. per sq. cm., so that, although standardised, this rubber shows appreciable variation. The mixture adopted in all cases consisted of rubber and sulphur only, and the cures were all press or mould cures. Different methods of experimental procedure, especially shape and type of test piece, may lead to different results. Nevertheless, the difference in the magnitude of the results obtained is so great that further comment is useless until these discrepancies are cleared up by the publication of fuller information.

I may here refer to a vulcanising test made on a sample of sprayed rubber from which a great part of the serum constituents (7.5 per cent. on the rubber) had been extracted by crepeing the rubber, soaking in water and recrepeing. This procedure yields a rubber having a higher tensile strength, but which vulcanises at approximately the same rate as before extraction. As a higher tensile strength results from the removal of the greater part of the water-soluble serum substances, these latter appear to act as diluents. The substances which cause the increased rate of cure of slab rubber are not readily water soluble, but are mainly retained by the rubber. It is interesting to recall a similar behaviour in the case of " slab " rubber (unrolled sheet which has been allowed to putrify). The accelerating base formed by the putrefaction is not easily washed out of the rubber, and is mainly retained when the " slab " is converted into crepe.

My experiments with sprayed rubber have not been confined to a " pure " rubber-sulphur mixing, but include such containing

zinc oxide, litharge and organic accelerators. So far, the results indicate moderate tensile figures, usually lower than those obtainable with the best plantation sheet and crepe. In the presence of litharge, there is very little, if any, difference in rate of cure between sprayed rubber and plantation sheet, that is, when vulcanised in open steam side by side.

In respect of ageing properties, sprayed rubber shows an advantage over ordinary plantation sheet and crepe or fine Para. The figures are of some importance, and I give you the results in detail. All samples of rubber were broken down as usual and mixed with 7½ per cent. of sulphur. The sheeted mix was wrapped round mandrels, bound with cloth and vulcanised in open steam for 60, 70, 80 and 90 minutes at 35 lbs. pressure. Previous tests have indicated that the best cure for the rubber under these conditions lay at 70 or 80 minutes, and that at 90 minutes it was slightly over-cured. The range from 60 to 90 minutes, therefore, included slightly over- and under-cured specimens as well as those having approximately the correct cure.

My experience with ageing tests has been that the surface exposed has a considerable effect on the rate of deterioration. An ordinary Schopper ring, section 5mm. by 4mm., exposes less surface than a thin sheet or an elastic thread. The latter is of a similar composition—that is, a " pure " rubber-sulphur mixing. It was desired to produce results more in accordance with those obtained with technical products, such as elastic thread, and yet to vulcanise in a form which would yield reliable numerical results. For this purpose rings were made up much thinner than the Schopper standard. The rings used were cut from tubes 1mm. thick, so that the cross-section dimensions were 5mm. by 1mm. They had, therefore, one quarter the sectional area of the standard rings. Rings of these dimensions can be quite satisfactorily tested in the Schopper machine with the supplementary load taken off the weight lever.

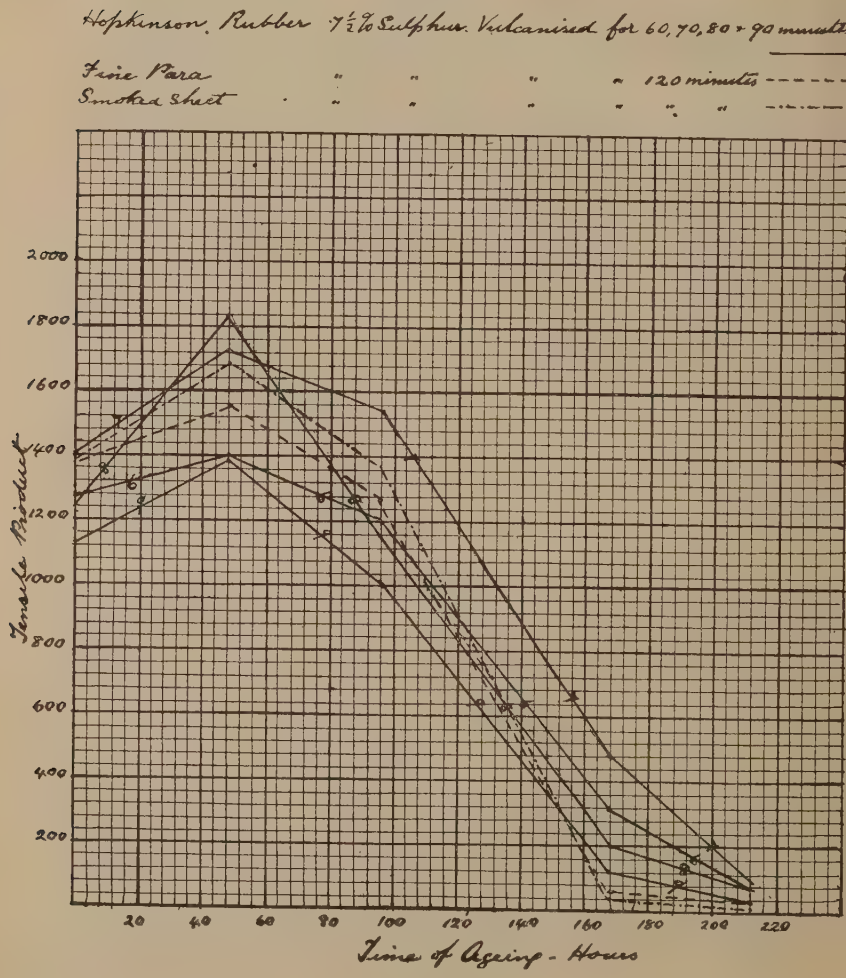
The rings were tested on the third day after vulcanising in the usual manner, and the remainder (eight of each mixing) were placed in an electrically-heated oven at 70°C, two rings of each being removed at intervals. The times of heating were somewhat over-estimated, and the third pair of rings, taken out at the end of the seventh day, were already weak, and in an advanced state of ageing. The last pair of rings were, therefore, left in for only two days longer.

Exactly similar tests were made with three samples of plantation sheet rubber, and three of washed, fine Para. These are shown as dotted lines in Fig. II. (" R.G.A. Bulletin," December, 1923, p. 698). The superiority of the sprayed rubber (continuous lines) is particularly noticeable at 168 hours, although at the end of the ageing period all samples tend to approximate to the same figure. The diagram gives the results obtained from the tensile product (product of tensile strength and elongation at rupture), but very similar curves are obtained for tensile strength alone.

They show clearly that the sprayed rubber at all cures in some ways ages better and at some periods shows better results than plantation or fine Para.

The improved ageing properties of sprayed rubber may be due to some intrinsic property of the rubber produced by this method of preparation, or it may result from the retention of the whole of the serum constituents. I have discussed the nature of these constituents earlier in this paper, and it seems probable that the ageing properties of sprayed rubber results

Figure II.



from (1) the protective effect of the serum constituents, particularly the methyl inositol, and (2) the greater rate of vulcanisation of sprayed rubber, as compared with ordinary smoked sheet or fine Para. It is well known that accelerators improve the quality of the rubber, probably by reducing the time or temperature of heating necessary to bring about the correct degree of vulcanisation.

To put this theory to the test I took some smoked sheet rubber and ascertained that approximately 3 per cent. of thiocarbanilide was required to give a rubber vulcanising at the same rate as the sprayed rubber. Sample 2 is a mixing made up on this formula. This rubber, however, contains only 3 per cent. of additional non-caoutchouc ingredients, as against the 10 per cent. of serum constituents in the sprayed rubber. A third sample was, therefore, prepared exactly as sample 2, but with the addition of 7 per cent. of inert matter, making, with the thiocarbanilide, 10 per cent. in all. This inert matter was made up of paraffin wax and bitumen. Sample 3, therefore, corresponds to sprayed rubber (sample 1), with the 10 per cent. of serum constituents replaced by—

3	per cent.	thiocarbanilide
3	,, ,,	paraffin wax
4	,, ,,	bitumen
10	,, ,,	

All three samples vulcanise approximately at the same rate, and were, therefore, vulcanised together and aged as in the previous series. The results are shown in Fig. III., and bear out my contention. Sample 2 gives the highest tensile figure, mainly because it contains, approximately, 10 per cent. more caoutchouc than samples 1 and 3. As, however, it does not contain the protective ingredients of 1 and 3, it does not age so well. The mixing 3 has one great advantage over 1, namely, it is much more plastic before vulcanising.

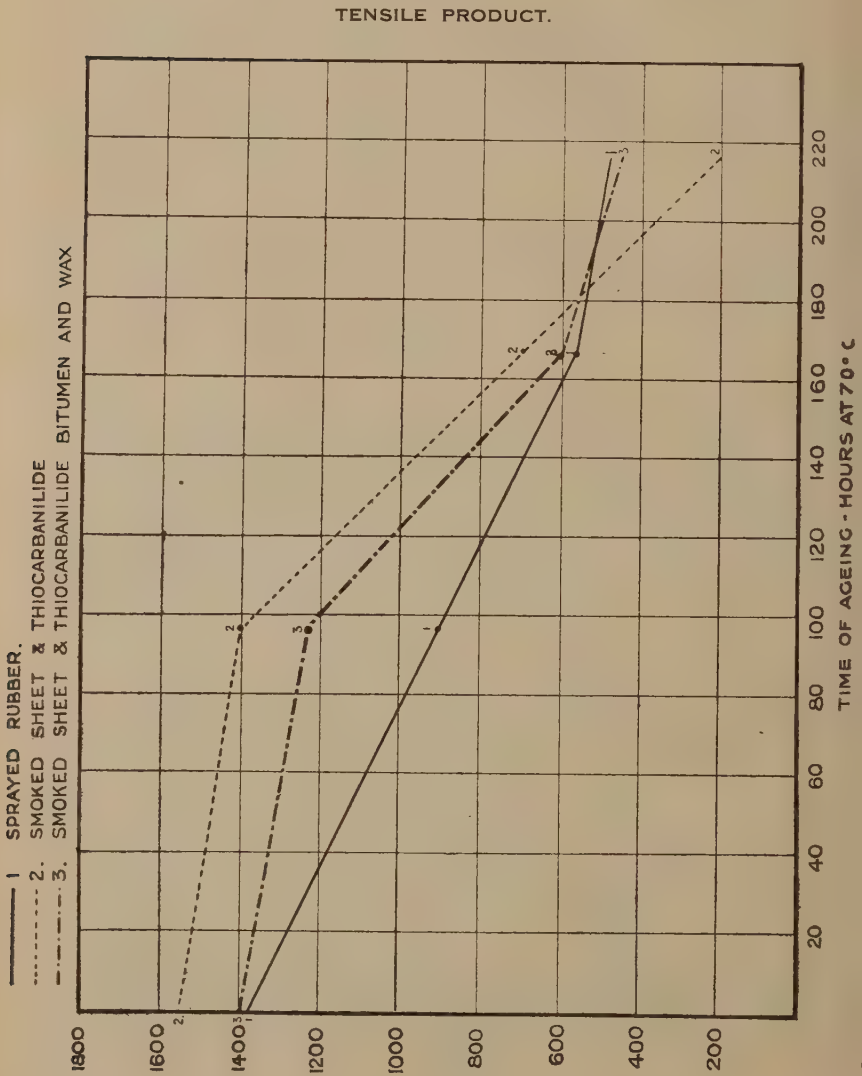
From my own and other published works, I arrive at the following conclusions :—

(1) Sprayed rubber is more difficult to break down on the mixing rolls than ordinary plantation rubber, and the product is less plastic. It is, therefore, less suitable for spewing from a tubing machine, or similar methods of manufacture. Softeners can, of course, be used, but these reduce the percentage of pure caoutchouc in the mix. On the other hand, smoked sheet, with added softeners, and containing the same percentage of caoutchouc as sprayed rubber, is quite plastic and easy to work.

(2) Sprayed rubber vulcanises almost twice as fast as ordinary plantation rubber in a pure rubber-sulphur 90/10 mix, partly owing to the use of ammonia in preserving the latex. A rubber, with a similar rate of cure, can be obtained with smoked sheet, by the addition of 3 per

cent. of thiocarbanilide, or smaller quantities of more powerful accelerators. In the presence of litharge, sprayed rubber shows no increase in rate of vulcanisation as compared with ordinarily-prepared plantation rubber.

Figure III.



(3) Sprayed rubber, when vulcanised, does not give higher tensile figures than plantation rubber ordinarily prepared. On the contrary, the figures are usually lower than for smoked sheet rubber. The lower figures are probably due to the dilution of the sprayed rubber with inert ingredients of the latex.

(4) Sprayed rubber, when vulcanised, ages better than plantation smoked sheet rubber or fine Para in consequence of the serum constituents. These latter can, however, be replaced by such inert materials as paraffin wax and bitumen with as good results.

DISCUSSION.

The CHAIRMAN: I should like on behalf of the Congress to thank and congratulate Dr. Stevens on the admirable paper he has given us this afternoon, a paper which is very full of meat. It is not a paper which can very easily be criticised, it is not very easy to see where holes can be picked, and it may be a little difficult to ask questions upon it unless one is primarily a rubber technologist, and not only a technologist but to some extent a chemist. That is an advantage which I see is held by quite a number of members of the audience, and as I have some claims in that direction myself I intend to lead the way by asking a few questions and making a few observations.

In the first place, can you tell me, Dr. Stevens, why there should be this large figure of practically 3 per cent. of moisture in the "whole latex," as presumably that has been dried right down to a dry solid in the same way that Sprayed Rubber has been dried down in the evaporation?

Dr. STEVENS: That is an anomaly, and I should have explained it. These figures were compiled from a number of analyses, partly my own, which were available. Where you are evaporating a latex it is difficult to dry it down completely. You cannot get the whole latex dry so readily as ordinary types such as crepe rubber. The higher percentage of moisture slightly affects the other figures, because these are obtained by difference, but it does not alter the general trend of the figures.

The CHAIRMAN: That is a very clear and full explanation of that point, which I confess a little bit startled me when he read the figures out. Dr. Stevens points out at the very beginning where the chemical differences between Sprayed Rubber and Plantation Rubber lie, and, as one might expect, he says the physical differences can be very largely explained by the chemical differences of Plantation Rubber as against Sprayed Rubber. So far so good. But then a very important point comes when one begins to look at it from a commercial point of view. What is the value of those differences, those technical differences, which the Sprayed Rubber shows as compared to Plantation Rubber? We see that to set against the positive advantages in Sprayed Rubber of quick curing and better ageing there are the actual

positive disadvantages of increased resistance on the rolls in breaking up; it is not so plastic and its tensiles are not so good. Dr. Stevens has shown how the advantages of quick curing and better ageing can be conferred on Plantation Rubber by suitable compounding, and also how the absence of the disadvantages as to plasticity and tensile strength is a point for Plantation Rubber. It would be interesting if one could assess in values, by so many cents. per pound, these two qualities, and try in this way to produce a balance sheet setting out the commercial advantage or disadvantage of Sprayed as compared with Plantation Rubber. On one side we should show the assets of quick curing and better ageing, and on the other side the lack of plasticity and loss of tensiles; and if one could possibly make a balance sheet as a lead to the general public in assessing the comparative values I think that would put the roof on the edifice which Dr. Stevens has built and explained to you this afternoon.

There is one other point which, of course, is quite apart from the physical side of the question, and that is—How is a special process such as the Sprayed Latex process to compare commercially with the standard process when it is a question of marketing one's produce? I want to lay a certain amount of stress upon this, because it is a point which will considerably affect plantation owners and growers of rubber. At present they can produce it, harvest it, dry it, and turn it into crepe or smoked sheet, and if necessary keep it. They need not sell it at the moment. They have the control of the marketing of their product in their own hands. If they intend to market it as Sprayed Rubber it will not be a case, I think, of practical politics for all estates to have their own spraying machines, because they are expensive and big, and it will therefore be necessary to have the Sprayed Rubber prepared by a central factory, and it will not be possible for them to keep their rubber when it has passed into the factory. Consequently, the growers of the rubber will lose touch at once with their produce, because it goes out of their hands from a commercial point of view as soon as it has passed into the spraying factory. That is, I think, a serious thing, and it will have to be carefully considered by owners who have thought of selling their product in the sprayed form. Are they prepared to lose control of their product? As long as they turn their product into crepe or sheet they can keep it and store it more or less indefinitely; they have the power to withhold it or put it on the market as they think fit. If it is to be dealt with as Sprayed Rubber they must sell as their crop comes in from day to day, and will never have the power of holding their product to meet the market and refusing to sell when the market is weak.

There is just this other point which we must not lose sight of. Sprayed Rubber contains approximately 88 per cent. of caoutchouc as against 94 per cent. of caoutchouc in Plantation Rubber. That is to say, the grower with his own spraying plants and who is turning his rubber out as Sprayed Rubber is getting from a gallon of latex a bigger weight of merchantable

product than the person who turns it out in the present form. In washed Plantation Rubber materials are washed away which would otherwise be sold or passed into manufacture in the final manufactured product, if the rubber be prepared as Sprayed Rubber. In the conditions under which the Sprayed Rubber would be prepared I very much doubt if the advantage of the increased weight of product would accrue to the plantation owner who would sell his rubber latex on percentage rubber contents, but rather to the owner of the spraying plant. This is looking a stage further than the technical aspect of the subject.

I throw this open to discussion, and I hope we shall have a very full one from every member present, from those who can speak from a technical point of view, and from those who take the commercial or—what shall I say?—the æsthetic point of view.

Mr. Quincy Tucker: I made many enquiries about Sprayed Rubber in America, and the general feeling is that the tensile strength is greater than that of Plantation Rubber. Dr. Stevens has said that it takes much longer to break down, and in many cases manufacturers have thrown it out for that reason. But I must challenge the statement as to the tensile strength, because I have made many enquiries in the United States, and there we find the tensile strength higher. It is my impression that the Rubber Growers' Association is trying to find the very best rubber in the world. Is that so?

The Chairman: Yes, undoubtedly.

Mr. Tucker: There has been a considerable diversity of opinion as to Sir Henry Wickham's rubber, but certain people in America think it gives unusual tensile strength. I took the trouble to get a test made in Boston, and it was shown to be much stronger than ordinary Plantation. Perhaps Dr. Stevens would be able to arrange to have tests made with Sir Henry Wickham's rubber?

Dr. Stevens: With regard to the tensiles. It is very difficult to understand how these figures in the United States were obtained. They usually express it in tons per square inch, but converting the figures in kilos. per square centimetre, which is the way on the Continent and in England, the figures published by the United States Rubber Company are enormously higher than anything obtainable elsewhere. The average figure they quote is 250 kilos. per centimetre for Sprayed Rubber, 227 for Plantation crepe and smoked sheet, and 213 for Fine Para. Now, my figures for Plantation crepe and sheet are about 150 or 160 kilos., and Dr. de Vries, who has done a lot of careful work on this subject, gets figures of round about 150 kilos. So there seems to be some method adopted in the United States which enables them to get figures which are high out of all proportion compared with what we can obtain with the Schopper machine in the ordinary way. That makes it difficult to criticise the United States figures. I may say I wrote to Dr. de Vries and

had a letter in reply only a few days ago about the results he had obtained when testing Mr. Hopkinson's Sprayed Rubber, and he gives a figure of 145 kilos. per square centimetre as being the tensile strength of all mixtures made with Hopkinson Spread Rubber. I should think probably it was the stuff made in Sumatra. My tests were made with rubber which I presume came from America, but my figures agree very closely with those obtained by Dr. de Vries, and we both agree that best Plantation Rubber, especially sheet, will give a little higher figure than Sprayed Rubber.

As regards Sir Henry Wickham's rubber, made by his company's process, I have not made any tests on the rubber they have prepared with their latest type of machine, but tests made on rubber turned out by an earlier machine did not give exceptionally high figures.

Mr. TUCKER: I am under the impression that testing in the United States is not done with rubber alone. They put in other things, and in this test that was made with Sir Henry Wickham's rubber I know they cut down the compound a good deal in order to make it a practical compound; and perhaps that is where they found the superiority.

Dr. STEVENS: Mr. Hopkinson and those who are working with him have published figures for "pure" rubber sulphur mixings and also compounded mixings, and whichever one takes I have not been able to get such good figures.

Mr. TUCKER: Perhaps you would like to get in touch with Mr. E. Buckleton, who has now gone back to London. He said he had got as high as 400 lbs. to the square inch, expressing it in the other way.

Dr. STEVENS: Of course, you can easily turn one into another.

Mr. J. G. FOL: The difference in the results must be caused by different methods of testing.

Dr. STEVENS: Yes, I understand that strips are used, and they give rather higher figures, but you see the differences in the figures are enormous: the result is 70 per cent. greater. I believe you might get 10 or 20 per cent. higher figures by using strips.

The CHAIRMAN: Mr. Hopkinson sent some of these strips over to show us.

Mr. FOL: Have you tested the strips?

Dr. STEVENS: No; all this work was done on rings. I have done some mould testings, but these were also made in the form of rings.

Mr. FOL: Have you made experiments after having the Sprayed Rubber washed? It would be interesting, giving an in-

sight as to effect of drying and the Hopkinson process. I cannot understand the figures of Dr. Stevens as to resins. Can you say, Dr. Stevens, why the resin content is higher in Sprayed Rubber than in Plantation crepe and sheet? Perhaps it is the spraying process itself?

Dr. Stevens: Possibly something is so modified by the heat and air as to make it into acetone soluble. As regards the question of the washed sprayed rubber, the effect of putting Sprayed Rubber through the washing mill in the ordinary way is to remove a very little of the ordinary ingredients, but I quoted in the paper some tests made in the following fashion. The Sprayed Rubber was cut into thin slices with a knife and allowed to soak for long periods, I think about three months, in water, the water being poured off and renewed from time to time. The rubber was taken out, washed and rolled into crepe form, then hung up and dried; when tested by my method the washed rubber gave better results than before treatment. The ingredients removed were, I think, about 7 per cent., and after removing these theoretically useless ingredients, improved physical properties were obtained.

Mr. Houwink: Can Dr. Stevens give us some figures about the uniformity of curing velocity of Hopkinson rubber? I have seen figures from America showing that it was of greater curing velocity than Plantation crepe and sheet.

Dr. Stevens: I have not had a sufficient number of samples for comparative purposes. I have had altogether three samples, and how far they were distinct I do not know. Two came together and one later on. Of these three samples two showed very similar results; the third one showed not much difference, but it was distinctly different in rate of curing. As far as I could judge from my tests I should say that Sprayed Rubber does tend to be uniform, possibly more so than Plantation Rubber. But I would not like to make a definite statement without testing a larger number of samples.

The Chairman: One would expect that it would tend to limit any slight variations in the latex taken from day to day.

Dr. Stevens: You would get a better average.

The Chairman: I think there is only one thing left to do, and that is to convey our heartiest thanks to Dr. Stevens for this admirable paper he has given us, and to thank him for the trouble of coming over here and reading it to us.

A CONSIDERATION OF THE PRESENT CONDITION OF THE EARLIEST HEVEA PLANTINGS IN THE EAST.

By HERBERT C. PINCHING, A.R.C.Sc.,

Senior Scientific Officer of the Rubber Growers' Association (Incor.).

Mr. P. J. Burgess presided.

The following paper by Mr. Herbert C. Pinching, A.R.C.Sc., entitled "A Consideration of the Present Condition of the Earliest Hevea Plantings in the East," was read by Dr. Stevens, in the absence of the author :—

The questions as to what is the natural average length of life of a rubber tree, and for how many years one may expect a field of *Hevea* to continue as a latex producer on a profit-bearing scale, have been raised from time to time by those interested in the rubber-growing industry. Several attempts have been made to give definite replies to these questions, and amongst those replies which have been published might be mentioned that contained in an article by J. S. Ferguson, to which was given considerable publicity by periodicals interested in rubber growing.* In this article it was stated that "For commercial purposes one must decide upon the period of 'life' or usefulness of the tree for the purposes of rubber production, and in the light of present-day knowledge I do not consider that this can with safety be put at more than 35 years." Unfortunately, no basis for the estimate of 35 years was given in the article, and therefore one must presume that the figure chosen was only a shrewd guess on the part of the writer. The rubber-growing industry is too much in its infancy to be able to supply definite data which would assist in answering these questions with any certainty. For several years to come even the oldest plantings will give but indefinite indications as to the possible longevity of the modern estate, on account of the conditions under which the more recently planted trees have existed from their earliest days, and the treatment meted out to them in tapping, cessation of drastic pruning, etc., being far more favourable to the vigorous growth of the trees, and hence possibly to a longer life, than the conditions and treatment under which

* "R.G.A. Bulletin," July, 1921; "India-Rubber Journal"; "Planter," September, 1921; "Malayan Tin and Rubber Journal"; "Planters' Chronicle."

the earlier-planted trees have maintained their existence. As opposing the possibility of a greater longevity of more recently planted trees, on account of the more favourable conditions under which they exist, one might raise the possibility of the weakening of the strain of *Hevea* now planted in the rubber-growing countries of the East and Middle East by the repeated inbreeding which has taken place. It will be obvious that at the present time it is impossible to make any dictum dealing with the comparative longevities of the oldest and modern-planted *Hevea* on estates.

It is difficult to form any idea of what is the general opinion of those who control the rubber-growing industry on what is considered the length of the productive life of a field of rubber trees. A few companies possessing old planted areas have suggested the replanting of these old areas for one reason or another, and a very few companies have actually carried out a replanting scheme over a few acres. Generally speaking, however, it would seem that it is considered that the question of the termination of the productive life of a field of rubber belongs too much to the distant future to call for any serious attention from those who are interested in the industry at the present day. The writer knows of no rubber-growing company which has included in its financial workings a fund for the amortisation of the trees, and it would seem that it has been tacitly assumed by those who control rubber-growing properties that the latex-bearing value of a field of trees is a stationary quantity for a sufficient number of years to be considered in perpetuity, at least for the present generation.

The writer's duties as Senior Scientific Officer of the Rubber Growers' Association have presented to him ideal opportunities for inspecting old plantings of hevea in Malaya, Ceylon, Sumatra, Burma, and Java in the light of the questions under consideration. Though the results of these investigations do not justify the writer making any definite statement as to the number of years one may expect a field of rubber, either in the oldest plantings or the most modern, to live or to continue yielding latex in sufficient quantities as to render the tapping of it a profitable procedure, yet it would seem to him that these results do justify his calling the attention of those interested in rubber growing to the matter of what is to be expected of the old plantings, what is the best treatment (from the financial as well as the health of the tree standpoint) to mete out to them, and to consider the question of replanting such areas.

The question of what is the average span of life of a rubber tree is not quite the same as that of what will be the revenue-bearing life of a field of rubber trees. While a rubber tree lives it will continue to carry laticiferous vessels in its cortical layers, and the latex will exude when the cortical layers are cut. It will be readily appreciated, however, that the quantity of latex which exudes may not be sufficient to justify the tapping of the tree, that the " bark " of the tree may be in such a state to prohibit tapping operations by the usually adopted methods (due to over-tapping in the past, poor bark renewal, or effects of such diseases as " mouldy rot " or " black thread canker ") or that the number of trees which remain in a tappable condition per acre may yield

too small a quantity of latex to render the tapping of the field a profitable business. It is obvious that it is the revenue-bearing life of a field of rubber trees which is of importance to rubber growers, and that the question of the length of life of a rubber tree is only of interest in so far as it affects this matter.

Unfortunately, one can get no definite information as to the maximum age which the rubber tree, *Hevea braziliensis*, attains in its natural habitat in the Amazon region. It has been suggested that well over one hundred years is of common occurrence. The treatment which has been meted out to the trees in the Amazon region would depreciate in value any data obtained from them as a basis of estimation of the longevity of the trees growing on plantations under more rational (according to present-day scientific ideas) conditions, while the removal of the trees from their natural habitat must certainly be taken into consideration in comparing the possible length of life of the trees in the Amazon region with that of the trees on the plantations of the East and the Middle East. Looking at the oldest plantings of hevea in the East, one finds that some of the original 1876 trees of Wickham's stock are still living in Ceylon in the Experimental Gardens at Peradeniya and Henaratgoda. In Lower Burma, at Mergui, on the property belonging to the Mergui Crown Rubber Co., many of the original trees sent over from Ceylon in 1878 still flourish, in spite of the drastic tapping and the overcrowding which they sustained in the years gone by. Examination of such old trees as these cannot fail to impress one with the extreme hardiness of *Hevea braziliensis*.

During a tour of inspection over some of the oldest fields of rubber trees in the Malay Peninsula, Sumatra, and the other rubber-growing countries of the East during the last year, the writer was struck with the somewhat distressed appearance of some of these older areas, and he feels that he can state without fear of contradiction that some of these rubber plantings are already past their prime. In some cases root diseases continue to make a steady claim upon the trees—one tree this month, another in six months' time—so that it is obvious that eventually insufficient trees will remain per acre to render the working of that area, its tapping, weeding, etc., a profitable business. In other areas it would seem that the growth of the trees has come to a standstill, and the leafless extremities of the topmost branches now stand out like staghorns. In other areas, due to excessive bark consumption in the days gone by, together with faulty tapping work, the "bark" of the lower portions of the trunks of the trees is too thin or gnarled to permit tapping. As the writer has been called in professionally during the last few months to advise in connection with old plantings which can be allocated under the above three sections or combinations of these sections, he feels that a short discussion upon each of these sections may be of interest and service to rubber growers.

Old Plantings with Reference to Root Diseases and Other Pests and Diseases.

In the earliest days of planting rubber, in the rush for acres planted up, no thought or attention was given to the matter of the

and chips are perfectly natural consequences of transportation." Not many of you would purchase such shoes, even at a reduced price. Nor, were you to take dinner at the Ritz or Cirro's, would you scarcely expect to be served bread that was dark in colour and full of chips, or the famous roast beef of England that was overdone; I am inclined to believe you would object seriously. Ah, you say, but a high price is paid; we must, therefore, expect only the best.

These remarks are given to show, if possible, the point of view that you have as the consumer of your own daily needs, and to translate this point of view over into that of the consumer of crude rubber, who is so many, many miles away, in an effort, by a simple comparison, to stimulate an improvement in a field where considerable improvement is needed. It matters not the cost nor the conditions of the market; if you buy bread at a shilling a loaf, or a penny a loaf, you expect from bread a certain standard which the years of human experience have led you to demand. You expect from leather shoes, regardless of cost, when you buy them, a particular appearance and fundamental quality. So it is with rubber. The one unfortunate situation, however, lies in the distance between the source of production and the place of consumption, and the many hands through which the articles have to pass before they finally reach their destination.

Crude rubber, as it comes to us, is the most variable substance that enters our factories. When we buy zinc oxide, we know what to expect from each barrel. Even if we buy fabric, although in any one of the thousands of styles for a multitude of purposes, still we know what to expect. It is made for us by a system of specifications, and, by test, it is determined how well it meets those requirements. Carbon black, whiting, sulphur, is required to come into the rubber factories in uniform condition, day in and day out, or it is rejected and sent back to the manufacturers. Oils, fats, waxes, all conform to standards of uniformity. Yet, crude rubber, the one basic commodity of the industry, reaches us as variable as the weather. We do not specify, we cannot test.

This variation in quality can be prevented. Wet mould, edge mould and surface mould may be difficult to avoid, but can be overcome, nevertheless. Over-smoked and under-smoked sheets, rubber that has been stored in the sunlight and partially decomposed, all these variations can be corrected. You are particularly conservative on the difference between high and low grade coffee in your great country, yet we find two grades, and sometimes more, of crude rubber mixed in the same boxes to the detriment of the quality of the goods into which they go. It is a practice which reacts in a lack of confidence in the original suppliers.

Just how do these troubles affect the consumer? Dirt, in the form of chips from packing-boxes is a serious menace to quality of such articles as inner tubes. It is not possible by any

human or machine method to remove from the centre of a bale, or a case, *all* the dirt and chips, and it only takes one such little piece of foreign matter to work its way through a tube of an automobile tire when on the road until a slow leak developes, and the motorist comes to grief. Thousands of sheets of water-bottle stock are rejected by inspectors, because of minute quantities of dirt which creep into even the highest grade of crepe. In a large rubber plant, it is quite a task to unpack and prepare sufficient rubber for the compound rooms on a single day's run, for many thousands of pounds are needed. The rubber manufacturer naturally wishes to do this in the most efficient and economical manner. Any contamination of the crude rubber before it reaches the factory, or during the operation of opening the cases, naturally adds to the expense of preparation and causes delays in the process.

The experience of the consumer in handling the various types of packages which are used to-day should therefore be of interest, and a study which would lead to improvements in this field should eliminate a large part of the difficulty.

In this connection, let me say that, regardless of how much I may discuss the faults of crude rubber, I, nevertheless, must compliment the rubber growers on the steady improvement in quality. I have observed how plantation rubber, year by year, has steadily improved. The point I raise, therefore, on this fundamental difficulty is the pity of it. Can we not arrange a type of packing-box that will keep splendid rubber from a requirement that it be treated by washing and drying in the same way as the lowest grades?

We are receiving about equal amounts of rubber packed in the ordinary white or red wooden boxes, and three-ply veneered wood cases of the Venesta type. The ideal packing case should be easy to open for inspection and to close up again. It should be waterproof, to avoid mould during transportation. It should not break up with rough usage; in point of fact, a box must stand the abuse of being dropped with its two hundredweight without breaking.

There are several different types of boxes in use; some made from white wood and others from red wood. The boxes which come from Colombo, Ceylon, are of sturdy construction, made from heavy wood, which makes a good package from a shipping standpoint and usually reaches us intact. The package has the disadvantage of being somewhat difficult to open on account of the metal strips which are nailed around the box.

Blanket crepe from Malaya comes in very heavy, red wood boxes, which are received in a fairly good condition, but the interior of the boxes is not always smooth, and sometimes the rubber sticks and pulls off splinters.

The wooden box which reaches us in the poorest condition is a rather light-constructed, white wood case, with tongued and grooved corners, known as the Momi case. These cases seem to

break up badly in shipment, and very few come through which are not badly dilapidated.

The three-ply veneered wood case, bound at the corners with metal strips, is a real improvement over the wooden box. The sides are made of one piece of wood, and it is impossible for dirt to get into the rubber. They protect the rubber fairly well from moisture and dirt, and when properly constructed and made from good wood, reach us in good condition. However, increasing quantities of these cases are coming in made up of very poor wood. From experience, we find that the case stamped with the seal of Venesta is the best. Some cases, with the Dutch stamp, are very satisfactory, and again other Dutch-made cases are not quite so satisfactory on account of the use of inferior wood.

The main objection to the Venesta case is that it must be destroyed to be opened. If the Venesta case could be made with a lid, so that it could be opened and closed again it would make an ideal rubber case and offer many advantages, especially in sampling at the docks, and finally in removing the rubber at the plant.

In some recent lots received from the R.C.M.A. Dutch Indies, a decided improvement was made in the method of packing baled rubber. In these experimental lots variously-sized bales were tried out, and a covering of tobacco matting was used. This matting did not show any tendency to stick to the rubber, and was easily removed without producing any splinters that adhered to the outside of the rubber package. The rubber was also wrapped with sheets of the same grade, which protected it from any dirt which might sift through the matting. One lot of First Latex Crepe came in packages containing, approximately, 5 cubic feet, gross weight 184 lbs., and only showed 4 lbs. of tare. Another lot was packed in a smaller bale, about $2\frac{3}{4}$ cubic feet, gross weight $112\frac{1}{2}$ lbs., and showed $2\frac{1}{2}$ lbs. of tare. A small lot of smoked sheet in 5 cubic feet bale, gross weight 234 lbs., also showed 4 lbs. of tare. As compared with an average tare of 20 lbs. on boxed rubber, this reduced tare would mean a substantial saving in railroad freight.

One objection to baled rubber is the tendency of the bales to flow out of shape during storage and transportation. We have noted that this tendency exists to a greater extent in smoked sheet than it does in crepe rubbers. Baled smoked sheet also has a tendency to mass, making it impossible to pull the rubber apart by the methods ordinarily employed. This is not a serious objection when the rubber is taken directly to a cracker and washed, or when a saw or hydraulic press knife is used to cut up the bales, but it is a serious objection when it is desired to inspect by the method of pulling the sheets apart.

Taking these points into consideration, the baling method could not be used generally for smoked sheet, but the crepe rubber in tobacco matting, especially the small packages, looks promising, and we believe it would be practical to apply this method to all the better grades of crepe rubber. It is quite

likely that the very lowest grades would have the same tendency to mass that we find in the smoked sheets.

The tobacco matting packages would not be satisfactory unless the bales were wrapped with rubber, and much of the success of this method would depend on how well this was done. On the lots we received the wrapping was very carefully done. With the exception of rubber from Ceylon, all the better grades of Dutch rubber, possibly 80% of the English rubber from Malaya and 50% of Chinese rubber from the same district, is coming to us wrapped in sheets of rubber. We find that this operation is not always carried out as carefully as it should be, and often the rubber is not tightly lapped at the corners, which carelessness allows the dirt to get into the inside of the bale, thus defeating the purpose of the wrapping. We do believe, when properly carried out, the wrapping of the rubber is a most excellent feature. These wrappers do not often pull off as readily as they might, but some treatment along the lines worked out by Dr. H. P. Stevens* might solve this difficulty. In any event, this is not a serious matter, because, after the rubber is pulled apart, the wrapper can be removed in pieces quite easily. We have noticed that a wrapper of crepe on a smoked sheet bale comes off easier than when the same kind of rubber is used and vice versa.

In summing up the features which, in my judgment, would improve conditions as far as rubber packing is concerned, I would recommend :—

1. That the wrapping of sheets of rubber around the outside of the bale be continued, but more care be exercised, in order that it will be properly done.
2. That the Venesta type case, made of good wood, or an improved case of this type, which can more readily be opened, be adopted for rubber which must be boxed.
3. That all grades of crepe rubber, except the very soft ones, be packed in small bales covered with tobacco matting, or some similar material which does not have a tendency to stick to rubber.

The irregularities of rubber due to long times of storage is one of the recent observations. Dark, soft crepe has been seen incapable of use in the highest grades of articles, because evidently changed and deteriorated. Rubber that changes noticeably during storage, has probably been badly prepared. When stored in heat and sunlight, even the highest grades deteriorate. The consumer, therefore, has but one recourse : to accept rubber when of the quality to correspond to normal type, regardless of age. What happens after vulcanisation is not the question. Is the rubber a good delivery on a contract? That greatly interests the consumer. The estate manager can meet the issue by proper manufacture and storage. However, after exposure to sunlight, rubber is altered in vulcanisation properties. Fundamental properties express themselves in a factory in variations in working. If the same ostensible grade of crude rubber

* Note on " Treatment of Wrapper Sheets with Bromine," " Bulletin of the R.G.A.," March, 1923, p. 167.

one day runs rapidly through our mills and calenders, and the next day slowly, practical men can readily appreciate the effect such variation has upon workmen and output. Furthermore, changes in storage affect the rate of vulcanisation, the old rubber altering enough to give irregularity to the products made from it. There is no difficulty, either in rate of vulcanisation or physical properties, when the crude rubber is stored in the proper way, which means primarily in a dry condition away from the light. While most of the work in a study of storage has had to do with the high grades of first latex crepe or the prime sheets, there are many other grades which alter much more rapidly during storage.

We have heard a great deal of the effect of mould on crude rubber. Some seem to think that it is of no moment. However, from the observation of years in a factory, I am inclined to believe that the effect of surface mould is of little importance, provided the rubber may be used promptly after receipt. We must remember that mould grows upon the protein constituents of rubber. These are important; the rubber would not be quite the same without them; any change in them cannot fail to alter the rate of cure of the material and, simultaneously, the handling or working properties. Wet mould is simply that much worse. Rubber thus affected is always softer, irregular, and makes poorer quality articles, and, therefore, should be avoided as you would the plague. The rubber trade does not wish mouldy rubber. Why it is formed, and how, is something that is outside my province, but in a series of tests, run some time ago, to determine the effect of mould upon the curing properties of rubber, we found that all mouldy rubber is variable and uncertain. In any event, it necessitates extra work and, consequently, extra cost to the rubber goods manufacturer. He must separate the mouldy sheets from the good. Tests, of course, are difficult to conduct, for rubber itself, under the best of conditions, varies from plantation to plantation, even in the same grade, and I suppose the only real way to accurately determine the effect of mould would be to do it in the Far East at some experiment station, where a batch could be coagulated and made into one quality rubber, then the different parts separated, bringing some of them through to the highest quality, and others through to mouldy rubber of different types. My point of view, therefore, at the moment, cannot be a scientific one, but only the result of practical observations. We do not wish mouldy rubber.

Technical men often desire to co-ordinate the testing of crude rubber on the estates and in the factory. I am inclined to believe, however, that while co-operation directly between estates and factory is wise and valuable and something that will grow, yet the method of test must be different in each place. The rubber grower must test his product to determine its uniformity as crude rubber. This requires a testing method which will show the maximum variation in the rubber itself. Conversely, at the factory the formulas used for testing and the methods must be such that will show its adaptability to manufactured goods. This is, therefore, performed from the point of view of showing the minimum variation as rubber and the maximum variation as com-

pounded rubber, which are two radically different things. The use of accelerators of vulcanisation in the testing of crude rubber would be rather harmful to the rubber grower than advantageous, for it might lead him into wider ranges of production methods which would, in the end, be costly. It is, of course, somewhat singular to find purchase and sale of such a commodity based wholly upon appearance. But it would be quite impossible to formulate any system of testing reliable and quick enough to permit a rubber broker or a purchaser to gain knowledge of value in the handling of his products in the market. No, we must continue on the principle of appearance, but bring up the qualities to a much more uniform scale, so that appearance will mean more to both parties.

There have been many new grades of rubber, the Wickham process, the Sipef, the Java Para, the Kerbosch, the pressed block, the Brazilian balls, and those produced by the different methods that have been used to improve smoked sheet and crepe. With all of these experiments the manufacturer here is much interested. These rubbers all vary more or less in working properties, and I believe that manufacturers throughout America are greatly interested in such experiments, and are confident that improvements in quality will be made, provided such experiments do not lead to simply an increase in the number of grades. I hope the time will come when there will be a simplification of grades of crude rubber. That day will certainly be welcomed by manufacturers.

The rubber industry in America is the same that it is in Europe, differing only in certain details of practice. If the consumers of crude rubber, namely, the rubber goods manufacturers, would take the rubber producers somewhat more into their confidence, showing them how and why rubber is used, and the needs of the case, it would result in marked improvements.

Finally, may I pay a tribute to the Rubber Growers' Association, the Estate Manager, and the Experiment Station. They have improved quality and packing. Rubber has become more uniform, cleaner and better, even during the past two years. I believe that the efforts now put forth are appreciated on this side. We are glad to co-operate and assist in further developments.

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DISCUSSION.

The Chairman : I think it is very fortunate that we have had these two papers on the same afternoon. Mr. Fol has dealt

almost entirely with packing rubber in mats. An extraordinary thing happened the other day. We were told at a certain institution in London that one of the unfortunate impurities in a batch of rubber was not splinters or dirt or coffee beans, but a metal wrench which had been left in the case. We cannot look upon a metal wrench as a normal impurity; but I have myself seen that when cases are opened there may be dirt and all sorts of impurity in the centres of the rubber contents. There can be no question that that is a just cause of complaint. As you may know, it was something over a year ago that the recommendation was strongly put forward that all rubber should be wrapped in rubber of the same grade, so that whatever impurity might get into the case would not be able to work its way into the centre of the bale; but the great problem as I see it is not to make the rubber free from casual impurity and contamination but to protect the rubber from contamination after the case has been opened and the inside of the bale has been cut in the process of sampling, and there neither the process of external wrapping nor any improvement in casing will solve the problem. The only solution I see is that rubber should not be sampled at all, but its grade or mark should be passed on to the consumer, and, if necessary, after weighing or paying certain tolls on the wharf on account of sampling, it should go from the first hand to the final hand. Till we can come to a stage like that we shall not get rid of this perpetual trouble of impurities working into the mass of the rubber. I should like to hear the views of members, which will be recorded, and we will then ask Mr. Fol to reply.

Mr. Quincy Tucker: The Boston Woven Hose and Rubber Company have given up their washing machine entirely, and if they do not get clean rubber they turn it back. More factories are all the time giving up their washing machines and demanding clean rubber, and it is absolutely essential to make an arrangement to get it clean. Washing is a very expensive process, as you know.

Mr. Baxendale: I propose first of all to speak on one or two points in Mr. Fol's paper. I would like to ask him whether I heard him correctly that rubber packing was used for tobacco.

Mr. Fol: No, matting.

Mr. Baxendale: Oh, I beg pardon. The other point in his paper was this. I understood him to say it would be very easy to repair the mat in which the rubber was packed. Is that a rubber mat?

Mr. Fol: No, a rush mat.

Mr. Baxendale: Now, turning to the subject of Mr. Geer's paper. Twelve years ago in New York I was shown extraordinary mixtures of different coloured crepes that were being sold over there, and it was apparently understood that the planter was in some way responsible for that, and, to put it vulgarly,

my jacket was being dusted. But on further investigation I found that the cases—all the rubber then being bought in the London market for the United States—the cases were being opened in the London docks, and apparently the rubber was being re-shipped in other cases, and it would have been perfectly impossible for us to remedy the difficulties as long as the dealers in London and Liverpool continued on the same lines. I therefore, I think, was myself responsible for starting direct shipments to New York, and I hoped that the difficulties of which they had complained would be removed, but two years ago, when things were publicly said about our rubber, I found the explanation given was that exactly the same methods were being followed in Singapore and Colombo as had been adopted in London and Liverpool, and that our cases were being opened and re-packed.

Well, it seemed very difficult to deal with the question at all, and it seems to me that the only satisfactory way of settling the matter is to adopt the suggestion that has just been made by our Chairman, and that is that rubber should be bought on specification and not transferred into other cases after sampling. At the same time we may get the difficulty again of the damage to the cases in transit, and I sincerely hope that we shall be able to adopt some packing other than wood, either mat packing or crepe rubber packing. But if we go in for crepe packing we shall find that the rubber will be passing through the hands of the dock labourer, and will no doubt be torn to pieces just as it is when it comes over in the case. I am told that when they handle the rubber at the docks with those terrific hooks they rip the cases all to pieces, and I suppose they will rip a rubber covering or the rush matting covering in the same way. I think we urgently need some very serious investigation of the whole subject.

Mr. Frank G. Smith (Secretary, Rubber Growers' Association) : Might I remark on the question of packing in mats that that question has already been raised with the Rubber Association of America. The reply which came from them was that there would be great difficulty in connection with the sampling of the rubber. It is very interesting to hear the Chairman's suggestion, that we get over that difficulty if we can do away with the sampling, for that is the whole problem. In London the same difficulty arose. We had two experimental consignments sent from Southern India—two bales packed in low-grade crepe. One arrived in very good condition; the other bale was rather torn, during unloading probably, as Mr. Baxendale remarked. A hook apparently had got caught in the side of the bale and had ripped it up. When these two bales arrived I had some brokers up to open them, and when they unpacked the bales the rubber was found to be in good condition and the sheets fairly easy to separate. The rubber in one bale, however, had not been quite dry when packed, as there was evidence of mould in the middle. When I asked the brokers if that type of rubber would be accepted generally they said, No; the difficulty was the sampling, and

baled rubber would have to be on a special contract. I think the key to the whole position really lies in the sampling.

Mr. Fol: I should like to refer first to Dr. Geer's paper. In the first place, there is the point about the flowing out of the bales. I think that is due to the fact that the bales have not been made in a proper way. If too little pressure has been applied when making the bales they have a tendency to flow out. I have been much interested to hear Dr. Geer's opinion about the smoked sheet, that it becomes a mass and a solid block. I must agree that if that would happen always it would be an objection to some extent. However, the American manufacturers have in their factories large machines which cut these blocks very easily.

There is another thing Dr. Geer mentioned. He recommended us to make small bales in packing the crepe. But there are some expenses in the docks which are charged per bale, so if we should make small bales the expenses per lb. of rubber would be higher than if we make them large. For that reason Dr. de Vries, of the Central Station, recommends large bales of 75 kilogrammes of crepe, which works out at about 168 lbs. of rubber.

There is another thing I should like to remark. One of the gentlemen present here spoke about wrapping the rubber in the cases by using long pieces of crepe or sheet, using them as a lining for the cases. That is a method which has been tested on several occasions, but it is not so very efficient because the rubber wrapping sheets are displaced when the rubber is pressed into the case, and so the wrapper does not shut off the interior as it does when you wrap it after baling. I quite agree with you, Mr. Chairman, that it would be better to sell the rubber on specification and marks, and that we must get rid of that sampling as much as possible. As to Mr. Smith's statement that he found some mould in the rubber, I think that must have been due to the rubber itself when it was packed. It was not quite dry when it was shipped, and the trouble was not due to the mats.

The Chairman: I think it is quite clear that we have discussed to-day a question which is opening up a new phase of rubber packing, and although we may be only at the beginning it is, I think, a very important beginning. I think this is only one stage in the march of improvement in packing rubber and doing away with a few of the objections of manufacturers. That the trouble is not altogether due to the plantations is clear; it comes in some way in transport. If any cure is to come it must come through collaboration of the producing end in obtaining a suitable form of packages and of the actual users in facilitating the transport of the rubber from one end to another without unduly interfering with the contents in transit. I thank Mr. Fol for giving us this paper at such short notice, and I also tender our thanks to Dr. Geer for the paper he has been at such trouble to write and send to us.

THE EFFECT OF OILS ON THE VULCANISATION OF RUBBER.

By SAMUEL S. PICKLES, D.Sc. and H. TURNER, M.Sc.

Mr. CYRIL BAXENDALE, who presided, said: I have here a paper written by Mr. Samuel Pickles and Mr. H. Turner. The paper is entitled "The Effect of Oils on the Vulcanisation of Rubber," and I think we can get a good idea of the substance of the paper and the main points for our consideration in the brief description of how they conducted their experiment and in the concluding paragraph, and therefore with your permission I will leave the graphs on the table and not read the figures. Anybody who wishes to investigate the matter thoroughly can study the figures when they appear in the full report of the proceedings which will be published.

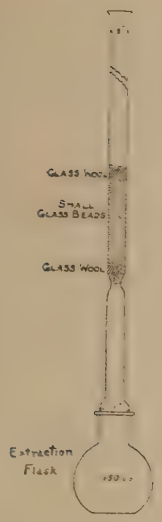
Reference to oils, mineral, vegetable and animal, is found in any comprehensive list of rubber compounding ingredients, but very little definite and reliable information has been published regarding the effects of these materials on the course of vulcanisation or on the character of the resulting products.

It was considered of interest, therefore, to make a brief investigation of the effects produced by the addition of small quantities of certain well-known oils to non-mineralised and mineralised mixings.

In the first case, in order to simplify the problem as much as possible, the well-known "test" mixture, consisting of 90 per cent. rubber and 10 per cent. sulphur, was chosen, and to this was added 2 per cent. of oil. Below is given a list of the oils used in the experiments, together with their physical and chemical characters. The oil described as "Rubber Oil" is a fairly high boiling fraction of the paraffin series corresponding to the light lubricating oil known as "spindle oil."

	Sp. Gr.	Acid-Value.	Saponification No.	Iodine Value.
Rape Oil ...	$\frac{25.0^\circ C.}{15.5^\circ C.} = .917$	0.64	193	110.9
Palm Oil ...	$\frac{51.0^\circ C.}{15.5^\circ} = .888$	67.7	198.8	55.4
Cotton Seed Oil	$\frac{22.5^\circ C.}{15.5^\circ} = .920$	0.60	193.4	109.4
Rubber Oil ...	$\frac{20.0^\circ C.}{15.5^\circ} = .899$	0.37	—	24.0

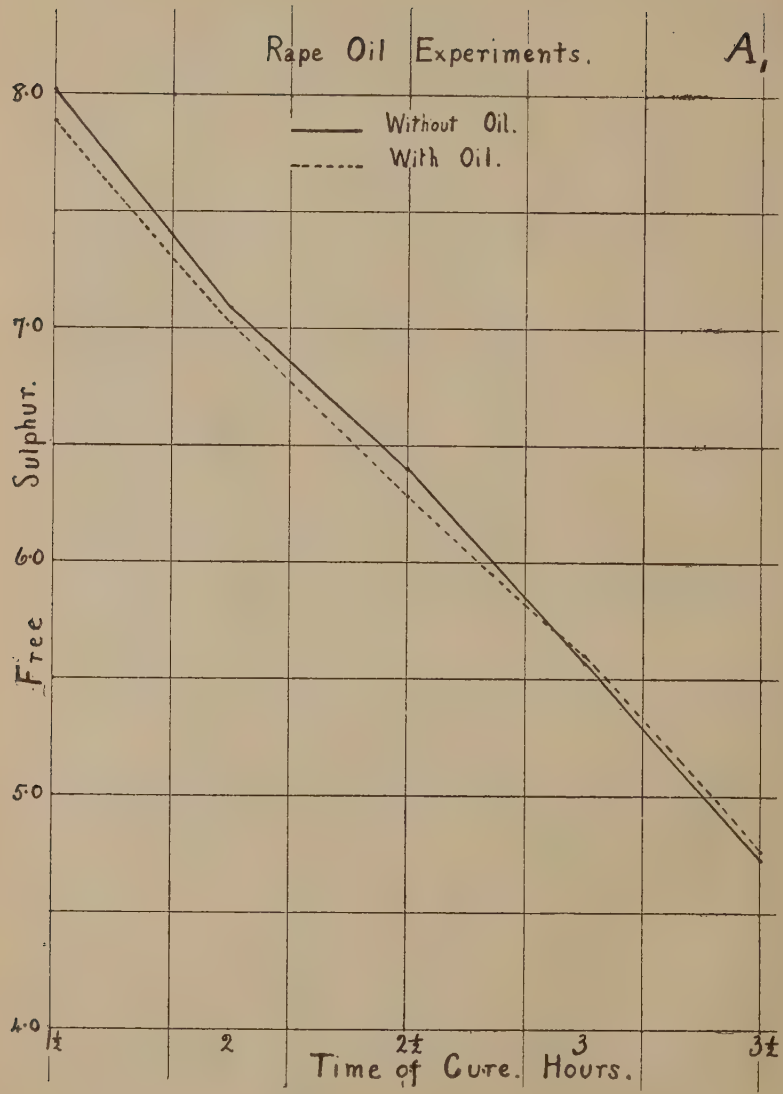
The rubber was masticated, and the sulphur was incorporated during a further ten minutes, care being taken that the mixing rolls should be only moderately warm during the process. The mixed batch was then divided into two portions, and to one of these 2 per cent. of its weight of oil was added. Thus, the portion containing the oil had a sulphur content of 9.8 per cent. approximately, as compared with 10 per cent. in the mixture without oil. Test pads, one from each portion, were then vulcanised in cast-iron moulds (in steam) for the same period of time, each pad being sufficiently large to allow of two rings being cut for the Schopper testing machine. The physical tests on the cured samples were conducted on the day following the vulcanisation. For the estimation of the free and combined sulphur, the remainder of each test-pad was creped on cold rolls, and in each case 1 gram of the material was taken and extracted for 20 hours with acetone in a Soxhlet apparatus. The oxidation of the free sulphur with nitric acid and bromine, and also of the combined sulphur, was carried out in the apparatus shown in the sketch. The sulphur was determined as barium sulphate. The values in the last column (see below), which are given for the compounds without oil only, serve as an indication of the degree of accuracy of the sulphur determinations.

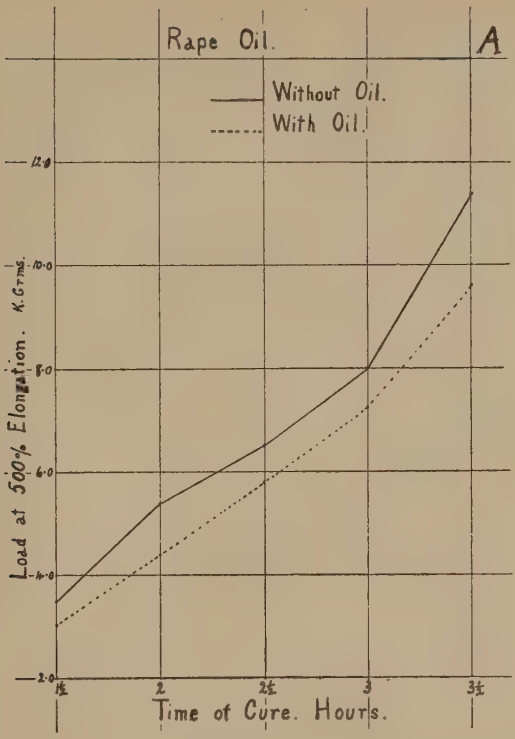


RAPE OIL EXPERIMENTS.

A = Compound without oil.
B = Compound with oil.

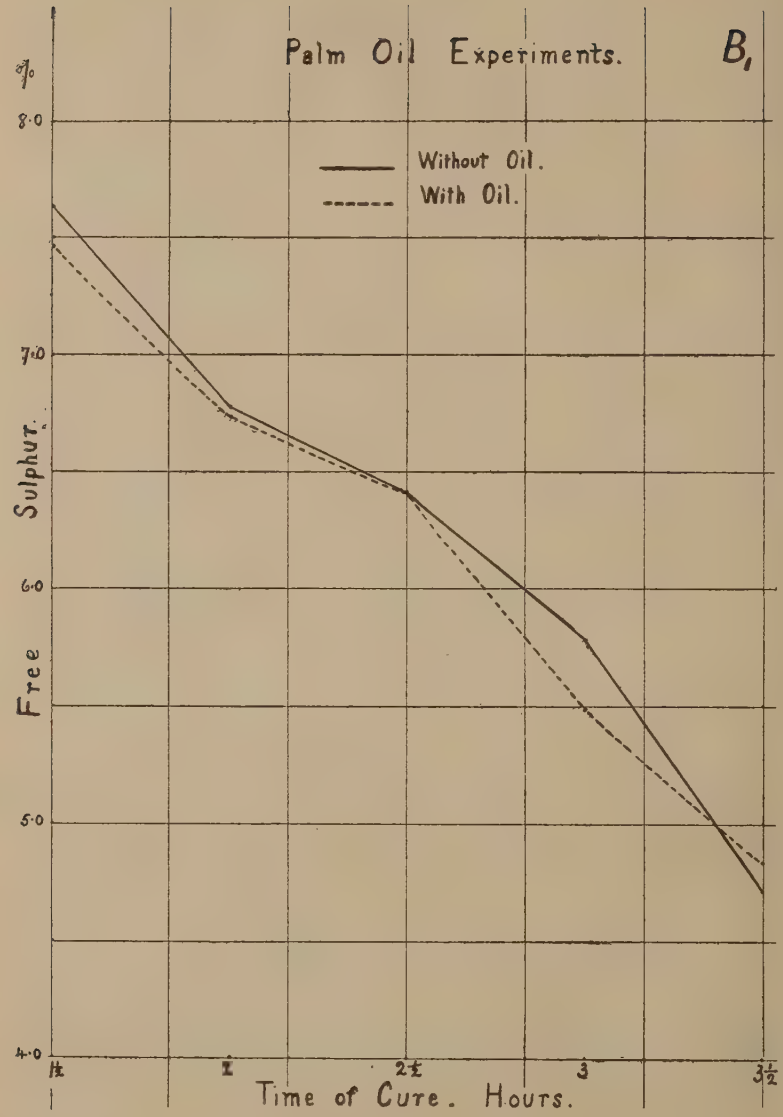
Time of Cure. Hours. at 290°F.		Load at Break. K. Grms.	Elongn. at Break. %	Load at 500% Elongn. K. Grms.	Free Sulphur. %	Combined Sulphur. %	Free + Combined. %
1½	A	16.7	926	3.5	8.02	2.03	10.05
	B	12.1	901	3.05	7.89		
2	A	27.9	900	5.4	7.09	3.03	10.12
	B	21.3	913	4.4	7.02		
2½	A	31.3	854	6.5	6.40	3.63	10.03
	B	25.0	849	5.8	6.28		
3	A	36.7	821	8.0	5.57	4.28	9.85
	B	30.3	811	7.25	5.60		
3½	A	22.6	580	11.4	4.73	5.33	10.06
	B	10.7	524	9.8	4.76		

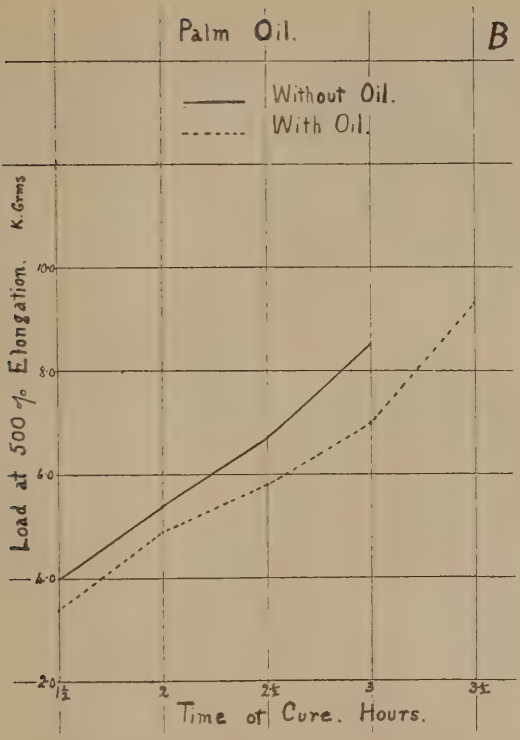

Rape Oil Experiments.
A,
Without Oil.
With Oil.
8·0
7·0
6·0
5·0
4·0
Free Sulphur.
1½
2
2½
3
3½
Time of Cure. Hours.



PALM OIL EXPERIMENTS.

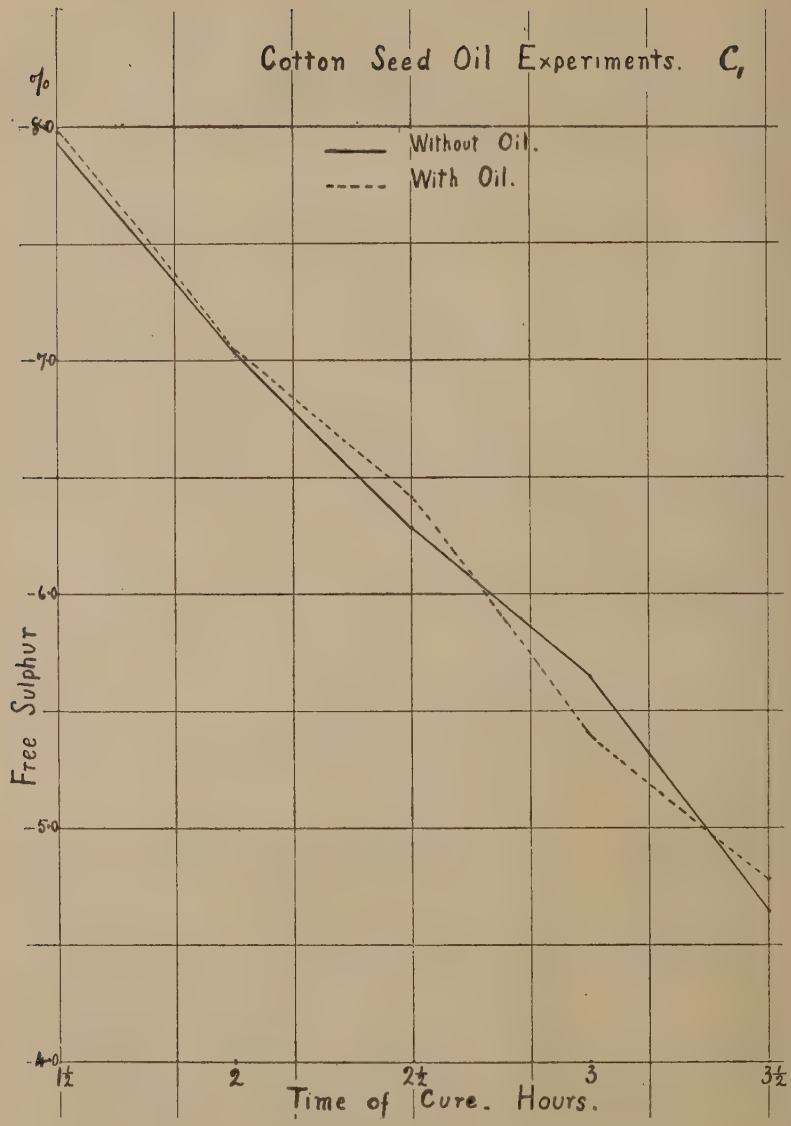
Time of Cure. Hours. at 290°F.		Load at Break. K. Grms.	Elongn. at Break. %	Load at 500% Elongn. K. Grms.	Free Sulphur. %	Combined Sulphur. %	Free + Combined. %
1½	A	19.4	920	4.0	7.64	2.25	9.89
	B	18.0	956	3.4	7.46		
2	A	28.2	891	5.4	6.78	3.18	9.96
	B	22.2	879	4.9	6.74		
2½	A	30.8	844	6.7	6.41	3.61	10.02
	B	28.5	877	5.8	6.41		
3	A	35.0	790	8.5	5.79	4.42	10.21
	B	20.6	753	7.0	5.49		
3½	A	7.6	403	—	4.71	5.45	10.16
	B	28.8	734	9.3	4.84		


Palm Oil Experiments.
B,
%
8·0
7·0
6·0
5·0
4·0
Free Sulphur.
Without Oil.
With Oil.
½
1
2½
3
3½
Time of Cure. Hours.



COTTON-SEED OIL EXPERIMENTS.

Time of Cure. Hours. at 290°F.		Load at Break. K. Grms.	Elongn. at Break. %	Load at 500% Elongn. K. Grms.	Free Sulphur. %	Combined Sulphur. %	Free + Combined. %
1½	A	19.1	936	3.7	7.93	2.14	10.07
	B	9.6	857	3.15	7.98		
2	A	25.1	877	5.25	7.04	3.07	10.11
	B	18.8	896	4.2	7.04		
2½	A	25.8	820	6.5	6.28	3.67	9.95
	B	24.2	831	6.1	6.41		
3	A	30.0	769	8.5	5.65	4.33	9.98
	B	20.4	730	7.6	5.40		
3½	A	33.8	726	10.9	4.65	5.14	9.79
	B	18.0	619	9.7	4.79		

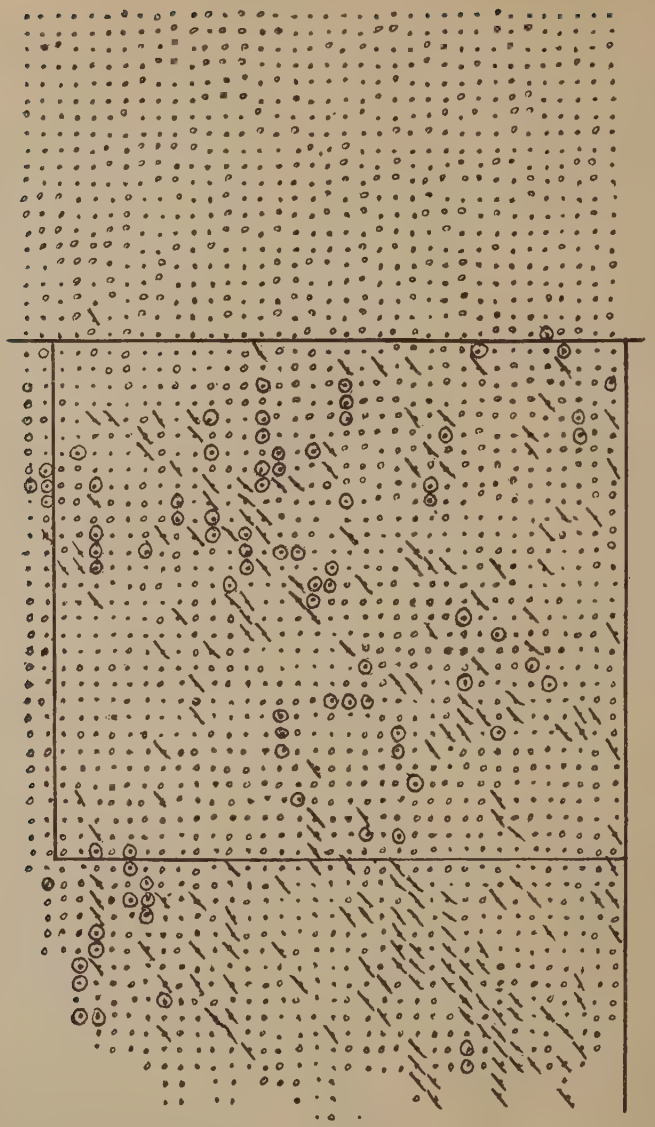

Cotton Seed Oil Experiments. C,
%
.80
.70
.60
.50
.40
Free Sulphur
Without Oil.
With Oil.
1½
2
2½
3
3½
Time of Cure. Hours.

clean clearing of jungle timber from the land. In fairness to the pioneer rubber planters, it should be stated that it was not then fully appreciated that the leaving of decaying jungle timber on the estate would prove harmful to the growing rubber trees. Investigations upon the appearance of *Fomes lignosus* (Klotsch) or *Fomes semitostus* (B. and Br.) as it was then known, and of white ants attacking the trees, showed that these troubles originated from the decaying jungle timber, both logs and the roots of jungle trees, and scientists advocated the complete removal of all such decaying wood from the estates as a means of preventing and combatting these pests. The extent to which this work of removal of jungle timber from the estates was carried out varied according to the opinion of those who controlled the estates upon the matter, and also according to the financial and labour means at their disposal.

Some of the pioneer planters scoffed at the idea of the removal of jungle timber. They dwelt on the manurial value of the decaying timber to the soil; losses by root diseases could well be sustained with the large number of trees which then stood per acre; the cost of removing the timber was thought to be too great in comparison with the possible returns (which could not be measured in £ s. d.) from the outlay. Some old planters known to the writer boasted of what profits they had already made from their rubber plantings without ever having spent a cent on the removal of timber, and that their estates were still existing, and bearing as well as many other estates where considerable amounts of money, time and labour, had been expended upon the clearing of timber. Unfortunately for the logic of the situation, chance played, or seemed to play, a very big part on the incidence of root diseases, and it would seem that in several cases where the early rubber planters scoffed at the idea of clearing timber very little disease made its appearance among the roots of their trees.

Some of the other early rubber planters merely contented themselves with removing the surface jungle timber from their estates, and left behind in the soil the decaying jungle roots, which were really the chief source of infection for the rubber trees. Others postponed the clearing of timber until the estate was in a profit-bearing stage. By that time, however, the soil was often heavily infected with such fungi as *Fomes lignosus*. Surprise has often been expressed to the writer by planters who have carried out this last-mentioned method when they found root diseases existing after the removal of the timber. As far as the writer knows, none of the oldest rubber plantings on jungle land were cleared of jungle timber before or immediately after the young stumps were planted out. When such fungi as *Fomes lignosus* have once infected an area the mere removal of the timber which acted as a host to those fungi may not necessarily free the area from the fungi. It is common experience on rubber estates to find the mycelial strands of the fungi permeating the soil independent of any decaying timber. The occurrence of root diseases from time to time in practically all old plantings of hevea, to a greater or less extent, has been the common experience, and from the above this is not to be surprised at. Though some old plantings appear to

DIAGRAM A.



• represents apparently healthy tree

● " original planted tree removed before trees of field were numbered.

⊙ " " " " after " " " " "

/ " " " " obviously affected by some root disease

Approximate area within ·· lines □ = 10 acres.

have been more fortunate than others in escaping the ravages of root-destroying fungi, and the damage done on some properties is practically negligible to date, it is difficult to point out generally the factors which have determined the extent of the activities of these fungi. One can find old plantings on the peaty and heavy clay soils of the coast district of Selangor as badly affected with, say, *Fomes lignosus* as the old plantings more inland, where the soil is naturally well drained and possesses a good tilth. The same can be said of the old plantings on the poorer, washed-out soils, and also those on light sandy soils.

Since the degree of incidence of root diseases varies so in old hevea plantings, it is impossible to give here any even approximate idea of the general condition of these areas with reference to this matter. On some areas the loss of trees through disease has been negligible, while on others known to the writer groups of twenty and even more trees have been lost. The following account of an area of 1906/1907 planted rubber in connection with the occurrence of disease and the loss of trees will be of interest.

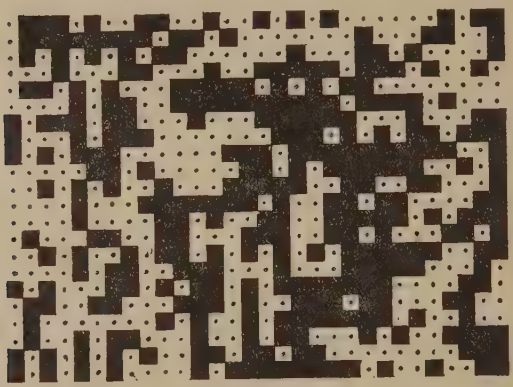
As will be seen from the accompanying plan of the field (Diagram A), the returns from about ten acres of the inspected plot have been examined. The original planting of the trees in 1906/1907 was 10 ft. by 10 ft., giving 217 trees per acre. During the years 1910/1912 alternate rows were more or less removed, leaving the planting 20 ft. by 20 ft., giving approximately 108 trees per acre. During the first part of the history of the field, 347 trees, or 32 per cent. from the trees of the retained rows, were lost by root disease (chiefly *Fomes lignosus*), white ants, wind breakage, and other causes. To keep a better check and control over the estate all the trees were numbered, and the numbers entered in a log-book. Since the time of the numbering a further 63 trees have been lost (equivalent to 6.76 per cent. of the desired stand per acre) from root disease and similar causes, while the recent examination of the remaining trees showed that 103 were obviously affected by root disease, principally *Fomes pseudoferreus* (Wakefield), since identified in Java as *Ganoderma ferreum* (Berkeley) by Steinmann. A careful examination, by opening up the roots of many of these affected trees, has shown that very little can be done in the way of treatment, the fungus having attacked the major portion of the roots. It is highly possible that several other apparently healthy trees are also affected, though to a less extent.

The area shown in diagram B should have contained 660 trees after thinning out. It now contains but 330 reputed healthy trees, the remainder having either been lost already or are doomed.

A consideration of the practical aspect of the matter of the incidence of root diseases in old rubber is of importance. It will be obvious that the complete eradication of root-destroying fungi from the soil in these areas will be a most difficult and expensive matter. Unfortunately, the external evidences of an attack by a root disease on a tree do not generally become apparent until the majority of the roots are affected and the tree is, in most cases, beyond satisfactory treatment. A longer than usual spell of dry

weather will often make the affected trees show up on account of the inability of their reduced root-spread to maintain a sufficient supply of water to the trees under the drought conditions. Examination of the roots of the trees adjacent to trees affected with root disease will sometimes result in the finding of the early stages of attack. The question of what is the best line of action to follow in connection with the occurrence of root diseases in the

DIAGRAM B.



■ represents lost & diseased trees

old plantings is not a simple one to answer, and no general statement can be made in reply. The treatment to be recommended must largely depend upon the following factors :—

(*a*) The number of trees affected.

(*b*) The stage at which the affection has arrived in the majority of cases.

(*c*) The general condition of the trees—*i.e.*, their yielding capacity, the state of the renewing bark.

(*d*) The spacing of the affected trees with reference to the area.

Consider for a minute an area of old rubber where every care has been taken to thin out all the poor-yielding trees and only high-yielders are now left. Every tree is now of great importance as a contributor to the yield per acre, such importance increasing with the fewer number of trees left standing per acre. It will be obvious that a very careful watch should be kept over such an area for the earliest signs of any root affection, and when such signs are observed the tree or trees should be opened up at once. Even

if as much as half the big lateral roots are found affected the progress of the disease can be hindered, if not stopped, by cutting away all the diseased roots and carefully covering the wounds thus made with a protective medium. If, as is generally the case with an attack of *Fomes lignosus*, the bole is affected on one side of the tree, then all the diseased wood should be chiselled away and the cavity made should be filled with concrete. Such tree-repair work is well worth carrying out in the case of high-yielding trees, especially where there are but comparatively few trees left standing per acre. In such an old field of rubber, where only high-yielding trees are now existing, when a tree is found affected with a root disease, then the neighbouring trees should have their roots carefully examined for any signs of fungal attack. If desired, an isolation drain, 2 ft. deep, could be dug around the group of trees surrounding the affected tree, though such a drain will not be of very great service in old rubber in reducing the amount of root disease in the area.

In an ordinary field of old rubber, where no great consideration was paid in the past to the latex-yielding properties of the individual trees when trees were selected for thinning out whether it is worth while carrying out a more or less expensive treatment of trees affected with root disease must necessarily depend upon the revenue-bearing value of the affected trees. Where the tree affected is a poor yielder, then it does not pay to carry out any treatment, for, after all, the results of any treatment, especially in advanced cases of root disease, are extremely problematical. The writer has seen in his career many cases of treated trees being blown over within a few days after treatment. Further, the treatment must depend upon the number of trees affected and upon the location of these affected trees. Where only occasional trees are found affected, then the kind of treatment to be meted out should depend upon the stage at which the disease has reached and the revenue-bearing value of the tree, as discussed above. Where, however, a large number of trees are affected, well distributed through the area, then the matter is a far different one. In such a case it is highly probable that the fungus causing the disease is well distributed through the soil, so that the digging of isolation drains round one or more obviously affected trees will serve but little purpose in preventing the further spread of the disease. It will be appreciated that such an area of rubber trees is doomed, though it is often very difficult to say for how many more years it will continue to yield sufficient latex to make tapping a profitable proposition. Gradually tree after tree will be lost. In spite of endeavours of the management to prevent such losses, and it seems that one must look forward to the time when there will be only a few trees surviving. Such a state of affairs may take five, ten, or even more years to be reached. Still, one must regard such an area as a wasting asset. Possibly the treatment of the affected trees might prolong the revenue-bearing life of the area by a few years, but nothing within the scope of practical planning policies could be done to bring the area into any condition of permanency. The proper treatment for trees affected with root diseases is an expensive procedure, and, in the writer's opinion, it is extremely

problematical whether it is worth while carrying out any treatment in such an area as is under consideration. It would seem to the writer that it is better just to remove the trees which are affected when they reach that stage of uselessness, and to plant up a fresh area to replace the doomed area. Unfortunately, some companies have no further land to plant up, and hence the above suggestion is useless to them. In their case the writer would suggest that it might be better not to carry out any treatment (except the removal of the useless diseased trees) until the area reaches the stage of having too few trees to permit profitable tapping, and then to remove all the standing trees and to prepare the area for replanting. It will be obvious that, since the soil is badly affected with the fungus causing root disease, every care must be taken to eradicate the fungus from the soil before replanting. Experience has already shown many rubber planters the futility of replanting on land affected with root diseases without taking great care to remove the causal fungi from the soil first. The writer has seen patches affected with *Fomes* replanted four or five times over, each planting eventually becoming affected with the fungus and dying off. Needless to say, the clearing of the soil of every vestige of rubber timber and root, the turning over of the soil, and the allowing of the area to lie fallow, will be an expensive matter; but unless this is done, and done properly, it is not worth while, in the writer's opinion, replanting the area.

Old Plantings with Reference to Cessation of Growth.

It would seem that on certain areas the growth of the old trees has got to a standstill, and examination of many such areas has shown to the writer that the principal cause of this is the adverse condition of the soil. In many cases it would appear that the soil is now deficient in food supplies for the trees, though in others the physical condition of the soil would appear to be at fault. Unfortunately, many of the older rubber estates are suffering from the clean weeding which was so rigorously carried out in the years gone by. The repeated scraping of the soil, the burning effects of the rays of the tropical sun, and the leaching effects of the heavy rains, have undoubtedly done much in removing plant-food material from the soil. Even on slightly undulating areas the " wash " of the surface soil is noticeable during heavy rains, while on the steeper hill-sides very little surface soil would be left after the combined action of the periodic clean weeding and the rains. A very noticeable case of the effects of clean weeding on a hill-side is to be seen in southern Kedah at the present time. Some thirteen years ago one side of the hill was planted up with *Hevea* and the surface kept religiously free from weedy growths. Three years ago the other side of the hill was planted up, and after one year's clean weeding it was allowed to go into grass (on account of the " slump " conditions which then prevailed), and attempts were made to more or less terrace this side of the hill. The original side of the hill to be planted was then kept unweeded, but no weeds, or practically none, will now grow. Needless to say, the thirteen-year-old rubber trees are very poorly grown, and appear to have made not the slightest progress for the last five

years. Still, where weeds will not grow how can one expect *Hevea* to prosper?

Many managements of rubber estates have done their best during the last few years to prevent any further loss of soil from their undulating planted lands by the cessation of the clean-weeding principle, the digging of contour drains, silt-pits or terraces, or the covering the soil with a " cover-crop." In some of the oldest planted areas it has been a case of " locking the stable door after the horse has been stolen." Still, where clean weeding has been stopped and the area covered with a suitable cover-crop, the soil should gain something from the decaying vegetable matter from these plants to replace that necessary food supply for the trees of which the soil has been robbed. In many cases these efforts have resulted in a distinct improvement in the appearance and general condition of the trees. It would seem, however, that when a tree gets into a " rut " of poor growth due to diminished vitality, brought about by poor soil conditions or unsuitable environmental conditions, it is extremely difficult to get the tree to respond to improvements in these conditions. It is extremely curious, but it would seem that the rate of growth of hevea on different classes of soil varies at different ages of the trees. On some soils the trees appear often to make excellent headway in the first few years of their lives, but after attaining their seventh or eighth year the rate of growth appears to slow off. On other soils it would seem that the trees encounter some difficulties in becoming established, and the rate of growth during the first few years is somewhat slow. After a few years, however, the rate of growth appears to quicken, and the result is quite satisfactory. Several areas of older trees examined by the writer would seem to come into the former class, and though in some cases strenuous efforts have been made to improve the soil conditions and to give the trees every chance of increasing their rate of growth by the stopping of tapping, yet no success has been obtained. The trees still have a " care-worn " appearance, their leaves are small and of a yellowish colour, the tips of the upper branches are bare of leaves, and the " bark," both renewing and virgin, is very hard.

Some estate managements, having been unsuccessful in their attempts to obtain an improvement in the growth of the trees, as described in the previous paragraph, have turned their attention to the question of replanting these areas. In view of the appearance of the original planted trees growing on these soils, one would not necessarily care to be too optimistic of the results of replanting these areas, at least without improving soil conditions and being successful in removing that factor which interfered with and hindered the growth of the first planting. The writer has recently seen a little replanting on such areas. In one case a considerable amount of trouble was taken with the holing for the second planting, and each hole was carefully manured. The replanting was expensive, though the young plants to date have a fairly satisfactory appearance.

Unfortunately, the soil requirements for the satisfactory growing of *Hevea,* from the available food-supply point of view, are

not understood, and the chemical analysis is of little assistance in showing why such soils as mentioned above will not maintain the growth of *Hevea* in a satisfactory condition for a long period. It has recently been found in Sumatra that certain soils when unmanured give rise to very poorly grown *Hevea,* but when these soils are manured with sodium nitrate or some other nitrogen-giving substance the growth of the trees is greatly improved, and that an increased yield of latex is also obtained. Such was not found, however, as the result of a chemical analysis of the soil in question, but as a result of an experimental inquiry in which several manures were experimented with

It would seem to the writer, in connection with these poorly grown old areas of *Hevea,* that it would be sounder financially to open up new areas to replace, rather than spend much money and labour in trying to improve, these old areas. There are fields of old *Hevea* in Malaya at the present time which have been resting from tapping for the last four years on account of backward growth, poor bark renewal, and being poor yielders. The writer can assert without fear of contradiction that if these areas were rested for a further forty years, if the land was manured, and everything done that is possible to improve the growth, not the slightest improvement would be obtained. In cases such as these it would seem that it were better to realise that such areas are finished, instead of trying to buoy up unjustifiable hopes that the resting from tapping and the other measures taken will be successful in getting an improved growth.

Old Plantings with Reference to Bark Renewal.

No one will deny that early systems of tapping were drastic, and made a great call upon the vitality of the trees. It would seem that the rapid removal of the " bark " in these systems of tapping, and the short period allowed for the renewing of the tapped bark before it was tapped again, had a marked detractive effect upon the rate of growth and general vitality of the trees. In many cases the milder systems of tapping which eventually took the place of the early drastic systems, together with the enforced resting of the trees from tapping on account of the renewing bark being too thin for tapping which had to be carried out on some properties, gave the oldest trees an opportunity to regain some of their lost vitality, while attention to the matter of the proper spacing of the trees and the thinning out of the excess number of trees resulted in an improved renewal of the tapped areas. In some cases, however, poverty or unsuitability of soil interfered with the growth of the trees, and this, together with the drastic tapping, had such a weakening effect upon the trees that they have never been able to recover under the improved conditions of more recent years in the matter of tapping and spacing. It is obvious that in such cases as these no hopes can be reasonably entertained of any improvement.

Several suggestions have been made from time to time with the object of assisting the renewal of the bark of rubber trees after tapping. The main idea in all these suggestions has been the

application of some mixture to the renewing area. Cow dung and clay mixtures were very popular for this purpose in Ceylon for many years, and there are still many planters who think that an improved renewal of bark is obtained by using them. Tar, tar mixtures, patent disinfectants, lime and lime mixtures have been similarly employed for the same purpose. Unfortunately, the advocates of these methods for the improvement of bark renewal are led away by the extra thick corky layer which is formed after these different substances are applied to renewing surfaces. To anyone who thinks the matter over carefully it is obvious that the renewal of the tapped cortex must depend upon the meristematic activity of the cambium, and that this activity is dependent upon the health (*i.e.*, food and water supply, freedom from disease, natural vitality) of the tree, and it is difficult to imagine how the application of these mixtures to the exterior of the bark (and there can be practically no penetration) can stimulate the cambium to a greater activity than it naturally possesses.

It has recently been suggested by one Malayan visiting agent that the application of the disinfectant solution to the renewing surfaces, as mentioned in the preceding paragraph, should be preceded by a light scraping of the renewing bark, as in so doing one would remove the corky layer, and the living cortical tissues thereby exposed would become suberised and part of the new corky layer (while a further layer of cells might be penetrated and killed off by the disinfectant solution, and these would also contribute towards the replacing corky layer), it is difficult to understand how such a method can result in a thicker living layer of renewed cortical tissues. It might be mentioned here that the same idea of scraping the bark of the rubber tree and applying a disinfectant solution has been advocated as a means of increasing the latex yield of trees. A warning against the unnecessary scraping of bark might be given here. Such a procedure can render the trees liable to attack by borers (*Xyloborus pavulus*). Sharples in 1915 issued a warning to rubber planters against such practices. Generally speaking, it may be taken that the rate of renewal of the bark of a tree is an expression of the vitality of that tree, and an improvement in the rate and nature of the renewal can only be obtained by stimulating the general growth of the tree.

Another factor which may interfere with the length of the profit-bearing life of the oldest rubber plantings is the possible advances which may be made in the latex-yielding powers of the trees of the present and future planting. If, by such methods as bud-grafting or by selection, it becomes possible to raise strains of high-yielding trees, so that an acre of such trees gave four or five times the yields from the average planted acre of to-day, then the old areas would not be able to compete against the modern plantings, and it is quite imaginable that old plantings would be gradually uprooted to make way for the new high-yielding strains of trees.

It will be gathered from what has been already written that, as there is a great variation in the condition of the older *Hevea*

plantings at the present time, it is impossible to suggest any definite period of years for the average revenue-bearing life of a field of *Hevea*. In some cases it would seem that certain fields had already reached their prime and that their days of usefulness were numbered by the time the trees were eighteen years old, while in other cases fields of twenty-five-year-old rubber trees look so vigorous and healthy that one could quite imagine them outliving the present generation of rubber shareholders. No generalisms can therefore be made as to the condition of the oldest fields of plantation *Hevea*, and each field must be considered on its own merits and treated accordingly. It is extremely desirable, in the writer's opinion, that estate managements, before undertaking any large programme of work with old fields of rubber, such as tree-to-tree inspection for root diseases and the treatment of diseased trees on a large scale, any attempt to improve the growth of such trees or their bark renewal which is going to entail considerable expense, or the replanting of old areas, should seek the assistance of a scientific expert and obtain from him a report upon the areas under consideration.

DISCUSSION.

The CHAIRMAN: That has been an interesting paper, and it is dealing with a subject about which there is much thought at the present time, and that is, how long our trees are going to last. I see Mr. Pinching is not in a position to give a precise answer to the question raised. He refers to the estimate of Ferguson of thirty-five years, but apparently he does not consider that estimate is based on much more than an opinion. He will not—and he is a wise man there—he will not give a figure himself. He says some trees at 25 years of age look good for another 25, and some of those that are only 10 or 15 years old look as if they are about done now, and he draws attention to the soil and the treatment which are probably responsible for their appearance. It would seem that the rubber tree is singularly like the human being in that respect. We have often seen youths who look almost fit for the grave, and men of 80 who look hale and hearty; and it must be the same with rubber trees. Only when the present generation of rubber trees has passed away shall we have an idea of the average life of a tree under present conditions.

I was rather depressed because Mr. Pinching laid much stress on the gloomy side of the position; for, like a doctor, he is dealing with disease, and when he writes at considerable length on disease conditions it makes one think that everything is diseased. But I assure you the rubber position is not one of disease as a whole, and that the unhealthy conditions to which he refers are not the average condition, though they are conditions to which, as a doctor, Mr. Pinching rightly calls our attention. It is interesting to note, too, what he says as to the external treatment of bark to stimulate its growth.

Mr. QUINCY TUCKER: I want to have it definitely understood

whether, if under present conditions you were opening up new areas, you would burn the felled forest now.

The CHAIRMAN: The practice is to clear it all off.

Mr. TUCKER: A few years ago Sir Henry Wickham was loud in his protest against clean weeding, and he turns out to have been right again, I think.

The CHAIRMAN: That is another very wide question, and there is no unanimity of opinion upon it. There are two ways of looking at it, and till you get the whole account closed over a period of fifty years you cannot say whether clean weeding or grass cover is on the average giving the biggest return. It will not depend on any one factor such as whether the tree lives longest under clean weeding or the reverse, but the answer must be determined by total profits when the book is finished and the last page blotted.

Mr. TUCKER: What is becoming of the leaves of the trees?

The CHAIRMAN: If the estate is on flat land the leaves rot, become humus and are absorbed again in the soil. You notice it on flat soil after the leaves fall; six months later if one stirs up the leaves which will have been lying there it will be found that they have all been pierced by little rootlets. I have often wondered myself, in the case of an area which is comparatively flat with little surface wash, covered by trees and with no extension in growth of the trees, what can then be taken from the soil to make it further impoverished? Whatever the tree sucks up from the soil in a manurial manner is all returned again, with the exception perhaps of 300 or 400 lbs. of rubber taken out during the year. I do not see how the soil can continue to be impoverished after a few years of growth, especially remembering the fact that the rubber which is harvested is 96 per cent. hydrocarbon, manufactured in the tree and not drawn from the soil.

Dr. STEVENS: When you have a tree ten or twelve years old the trees meet overhead and very little light gets through, so there is little tendency for weeds to grow. It is during the earlier years when the area is first planted up that weeding is so necessary. At first sight it appears as if there might be a halfway house; you could keep the ground sufficiently weeded to prevent other growths getting ahead and interfering with the growth of the trees, without actual clean weeding. But I think it is a fact that such a middle course is not possible. You must keep it clean for the first year or two, and I take it that it is in the first year or two that the main loss of soil occurs. I can remember after a heavy rain-storm seeing the water simply pouring off a sloping piece of planted ground, and it must have been carrying tons of soil with it. Of course, that occurring for two other years must have seriously denuded the land. I am speaking of fifteen

years ago. Things are different now, in particular pits are dug and terraces to retain the soil.

One thing the Chairman has touched on is the question of removing the tree stumps from the area, and burning up the stumps and loose timber before planting or in the earlier stages of planting. It is tremendously heavy work. But it certainly does not do to leave it very late, for I remember in one case a piece of land on which the trees were about two or three years old, and efforts were made to get out the rootlets and get rid of all the jungle timber on the ground. This was made up into heaps in different places and gradually burned away, but the result was that the cortex of the growing trees was badly scorched, and consequently much damage was done.

The CHAIRMAN: If there are no more questions or comments I think we will thank Mr. Pinching in the usual way for his paper.

PACKING RUBBER IN MATS.

By J. G. FOL,

Propaganda Secretary, International Association for Rubber Cultivation in the Netherlands Indies.

Mr. P. J. BURGESS, who presided, said: I now ask Mr. Fol to read his paper on "Packing Rubber in Mats," and I must put the scarcity of the attendance down not to lack of interest in the paper but to the inauspicious day on which you, Mr. Fol, have to read it, and the counter attraction of the review of the troops by His Majesty the King.

Mr. FOL: At one of the previous meetings of this Conference, attention was drawn to the fact that rubber shipped in cases very often arrived in a very poor condition in the docks and rubber factories. During the long transport the wooden cases get seriously damaged, and probably by the constant vibration in ship or train splinters find their way into the interior of the rubber. Opening the cases for inspection and sampling means another source of damage, and splinters and occasionally nails fall between the sheets of rubber, causing serious trouble in the manufacturing processes.

More particularly the cases shipped to America arrive there seriously damaged owing to the long voyage, and the fact that they have been repeatedly sampled and re-shipped. Often not one case out of several hundreds is intact, while a large number are completely destroyed. It is not exaggeration to say that if rubber has a long way to travel, a wooden case does not keep it clean, but actually contributes to its dirty condition and is the chief source of offence.

Various methods have been proposed to avoid these drawbacks, and the most promising seems to be baling the rubber and complete wrapping in sheets of the same rubber as the interior. When due attention is paid to the wrapper sheets fitting flat round the corner and ribs, the wrapping gives a complete protection against dust or dirt; only the outer layer gets dirty and the inner layers of the wrapping remain quite clean.

For the manufacturer this method of packing (as is also in use for the packing of that most precious and delicate of all tropical products, the Sumatra wrapper leaf tobacco) has the great advantage that the rubber is received in the same clean condition as the growers have shipped it from their estates. It will not be necessary to sort out and to brush the sheets of rubber which have become dirty. Re-washing as is done in some instances will become completely superfluous.

I will now deal with the advantages this method of packing gives to the planter.

I am sure that British rubber growers have been as much surprised as the Dutch by the enormous increase of the production of native rubber. Though there is a great lack of information as to the exact position of the native rubber and the areas planted and coming into bearing in the near future, we may safely say that the native rubber will become a keen competitor for the Plantation rubber, as the native is working under more favourable conditions (small taxes, no hospitals, no land rent, etc.) than the owners of the European estates. For a more successful competition, the latter will have to cut out all unnecessary expenses. Packing the rubber in mats will be helpful in reducing the f.o.b. cost of the rubber. This method is cheaper than wooden cases, not much, but certainly sufficient to induce rubber growers to give their full attention to the matter.

The next advantage is that mats are much more cheaply and more easily repaired at the docks than cases. The present expenses for cooperage and eventually for new cases will be greatly reduced.

Another advantage is that the tare is practically constant; therefore, difficulties arising out of differences in weight of wooden cases are avoided.

This new method has, of course, not been spared criticism. The principal argument is that in the rather hot hold of the ship the rubber may get soft, and by the weight of other cargo be pressed too heavily and form a solid block. Actual practice gained from large scale experiments in 1922—already 1,200 tons of rubber packed in mats have been shipped—proves that this fear is unfounded. The rubber having been pressed to about the same degree as when packed in cases, stands pressure very well, and instances of blocking are just as rare as with rubber packed in cases (where too severe pressing and blocking by heat also occasionally occur).

At this Conference several lecturers emphasised the need of close co-operation between producers and manufacturers. I am fully aware of the fact that the main stimulance for this new method of packing must in the first place come from manufacturers with the object to obtain cleaner rubber. However, I am also convinced of the need of a combined action of the Rubber Growers' Association and the International Association at The Hague in order to arouse the manufacturers' interest in this method of packing and to get the present forward contracts altered in such a way that the rubber may be packed either in cases or in mats. I am sure that these combined efforts will be at last to the benefit of all parties interested in our wonderful industry.

DISCUSSION.

The Chairman: I must first of all congratulate Mr. Fol upon the example he has given us of writing a paper and reading it in a language which is not his native tongue. I feel the greatest sense of admiration for his exploit. I think I will read at once

the next paper, by Dr. Geer, for it deals with the way in which plantation rubber arrives at the manufacturers' factories, and he makes various suggestions as to rubber packing. I think it would be a suitable occasion to take both papers together and have the discussion on both at once, if Mr. Fol is agreeable.

Mr. Fol: Certainly.

CRUDE RUBBER FROM THE CONSUMERS' POINT OF VIEW.

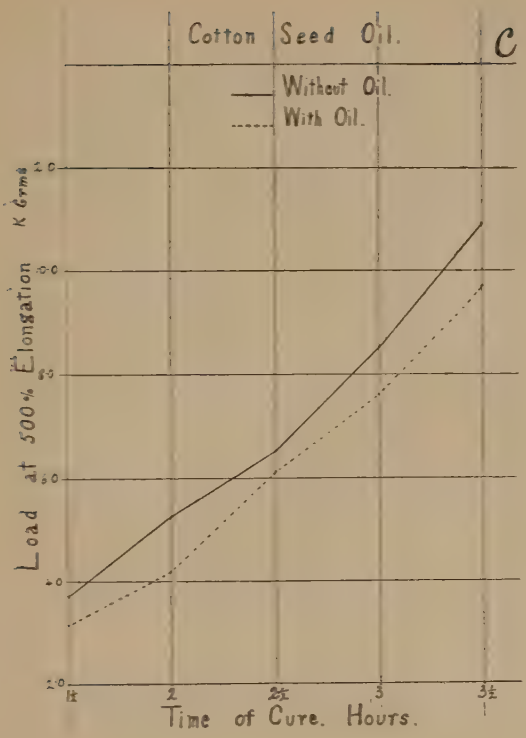
By WILLIAM C. GEER,

Vice-President, The B.F. Goodrich Rubber Company, Akron, Ohio.

The CHAIRMAN (Mr. P. J. Burgess) said: Dr. Geer is research chemist of the Goodrich Rubber Company, of Akron, United States. Three of us who went to America last year had the pleasure of making the acquaintance of Dr. Geer, who showed us the works and explained the plant in the company's factory to us; he came over to London a short time ago and read a paper he had written on rubber problems from the manufacturers' point of view. His paper to-day deals very largely with this question of packing, and I think it would be an advantage to have it read before we enter into a discussion of Mr. Fol's paper, which covers part of the same ground. Mr. Burgess then read the following paper:—

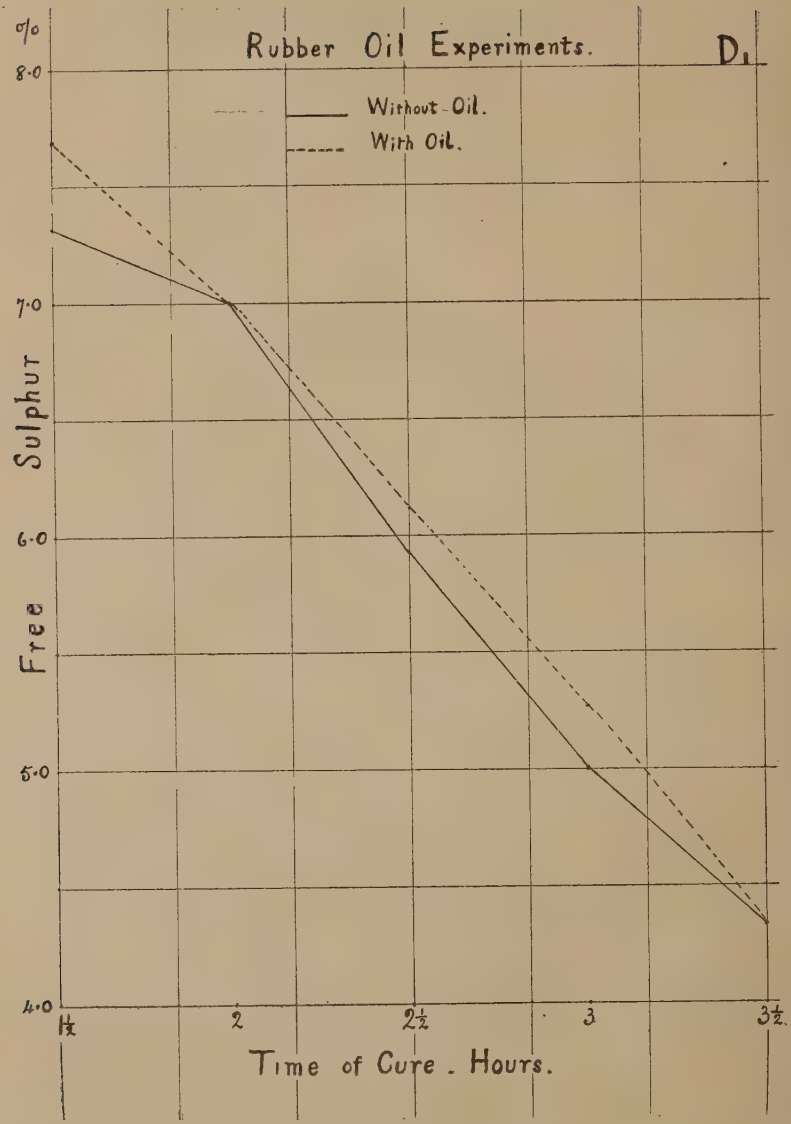
Most of us are apt to live too closely with our daily work. The conditions surrounding it seem proper and unchangeable. We travel from our homes in the morning by motor, tram, or Underground, to our places of business, but perceive little of the things we see. They are too familiar. The tram may be cool, or the Underground noisy. Nevertheless, we accept the conditions as part of the daily programme, which at the moment is acceptable as a matter of course.

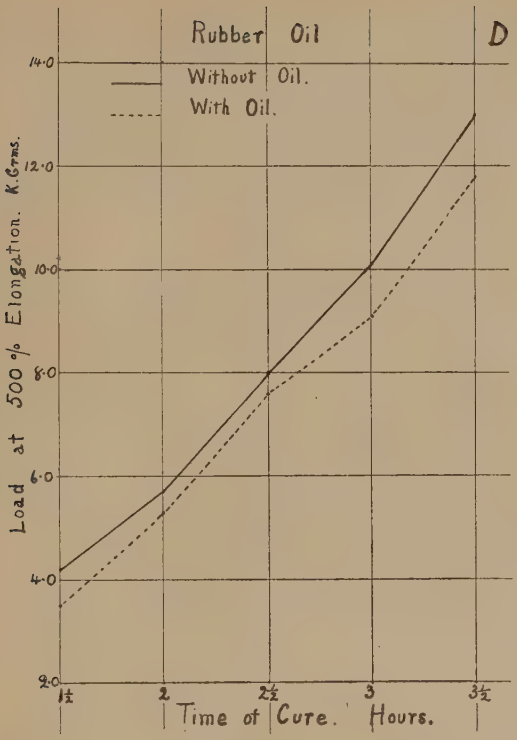
If we were to enter the shop of a dealer to purchase a pair of new rubber boots, we would naturally expect a beautiful article—glossy, capable of excellent wear, as well as refined in appearance. How great would be the shock, therefore, were he to produce a pair that was mouldy on the surface and had chips and sand on the inside. Yet, with perfect justification, the shopkeeper might say: "But it will wear well; you can easily brush off the mould, the chips may be shaken out—why complain?" "Ah," but you would say, "let us have it at a lower price." And your shopkeeper might reply, "But the *wear* is there just as well, why should not the price be fully equal? These boots were stored, unfortunately, where it was damp. In unpacking them, my assistants found that the transport workmen had broken one of these boxes and dragged it along a bit on the ground. The sand



RUBBER OIL EXPERIMENTS.

Time of Cure. Hours		Load at Break. K. Grms.	Elongn. at Break. %	Load at 500% Elongn. K. Grms.	Free Sulphur. %	Combined Sulphur. %	Free + Combined. %
1½	A	19.1	933	4.2	7.31	2.80	10.11
	B	13.0	889	3.5	7.69		
2	A	24.5	853	5.7	7.00	3.03	10.03
	B	22.3	860	5.3	7.00		
2½	A	32.0	806	8.0	5.92	4.20	10.12
	B	31.4	826	7.6	6.11		
3	A	32.0	737	10.1	5.00	4.81	9.81
	B	30.6	761	9.1	5.26		
3½	A	17.4	570	13.0	4.33	5.70	10.03
	B	14.4	547	11.8	4.33		


Rubber Oil Experiments.
D1
Without Oil.
With Oil.
%
8·0
7·0
6·0
5·0
4·0
Free Sulphur
1½
2
2½
3
3½
Time of Cure . Hours.



It will be seen from the above tables and graphs that there is no marked accelerating or retarding effect on the combination of rubber and sulphur produced by any of the oils examined. The results of the above physical tests show that each of the oils has a softening influence upon the vulcanised rubber-sulphur compound, but there is no great difference between them in that respect. It does not follow that the same result will be found for a mineralised rubber. Experiments show that in a mix containing whiting, zinc oxide, and litharge, palm oil produces a decided acceleration in the rate of cure. This is probably due to the acid character of the palm oil, as oleic acid produces a definite acceleration with the same compound.

DISCUSSION.

Mr. Quincy Tucker: Is the "Rubber Oil" the rubber seed oil? It probably is.

The Chairman: The authors do not describe it so, but it probably is. The only product of the rubber tree we can make oil out of is the seed.

Mr. Kaye: Do they not refer to paraffin?

The Chairman: Yes. I see they say that it is "a fairly high boiling fraction of the paraffin series corresponding to the light lubricating oil known as spindle oil." I should like to thank the authors for their contribution to our proceedings. I am woefully ignorant of the chemical side of the business, but imagine the experiment is very valuable. The effect, first of all, of softening the rubber would be, I suppose, very useful, and the acceleration without deterioration to the manufacturing value of the product is another achievement. These are the two points which occur to me.

Mr. Kaye: Yes, they are both important. The softening may be a decidedly good quality, as it is for other materials in some of those compounds that are used now, like "Rexine," and so on. They put oil in to prevent hardening. It is used in the furnishing trade. It may be that in some cases where rubber is used in a similar manner it could be a great advantage.

Mr. Tucker: But what is not mentioned in the paper is that it might be hardly suitable to use oil if it destroys in the long run. Some oils might cause the rubber to decompose.

Mr. Kaye: But that is not in the paper, and we can hardly discuss that point in this connection.

The Chairman: The softening of the rubber may be as valuable in some manufactured articles as the hardening is in vulcanite.

THE RÔLE OF ENZYMES IN THE COAGULATION OF HEVEA LATEX.

By Dr. O. DE VRIES,
Director of the Central Rubberstation, Buitenzorg (Java).

The CHAIRMAN (Mr. Cyril Baxendale): I will now ask Dr. van Rossem to read a paper by Dr. de Vries.

Dr. VON ROSSEM (for Dr. de Vries): Enzymes in Hevea latex were first described by D. SPENCE[1] and then studied in greater detail by G. S. WHITBY,[2] who clearly distinguished between an oxidising enzyme (causing the well-known violet surface discolouration of the coagulum, the darkening of brown crepe and similar phenomena, and called hevease by Whitby) and a coagulating enzyme playing a rôle in natural or spontaneous coagulation. The part played by an enzyme in the coagulation of latex then formed the subject of studies by L. E. CAMPBELL[3] and M. BARROWCLIFF,[4] and the arguments which seemed in favour of enzymic action were afterwards summarised by WHITBY[5] in so striking a manner, that subsequent authors not only regarded it as proved that a coagulating enzyme plays a rôle in latex coagulation, but also took a rather exaggerated view of its importance; the coagulation of Hevea latex was called an enzymic process, and the rôle of acids or other coagulants was reduced merely to a stimulating effect on the coagulating enzyme.[6]

The arguments brought forward to prove the rôle played by an enzyme are partly circumstantial, partly based on facts and experiments; but in many cases these facts are far from conclusive. In studying the literature on the subject, one is often struck by the fact that the experimental data can easily be explained in another way, or that the experimental evidence is far from sufficient to prove the conclusions drawn from it.

As an example of the first case, we may mention the phenomenon of the "gap" or "second liquid zone" described by WHITBY,[2] *i.e.*, the fact that by adding increasing amounts of acid to a diluted latex one reaches, from the first or original liquid zone, at first a region where coagulation or flocculation of the rubber occurs, but with more acid a zone where the mixture remains liquid, while still larger amounts of acid lead one into a second zone of coagulation. BARROWCLIFF[4] and WHITBY[5] sug-

1. D. SPENCE, Lectures on India Rubber (1908), 198.
2. G. S. WHITBY, Eighth Int. Congr. of Applied Chemistry, vol. 25, page 597, Ind. Rubb. Journ. 45 (1913), 74.
3. L. E. CAMPBELL, Journ. Soc. Chem. Ind. 36 (1917), 274.
4. M. BARROWCLIFF, Journ. Soc. Chem. Ind. 37 (1918), 48 T.
5. G. S. WHITBY, Agric. Bull. F.M.S. 6 1917, 374; "Plantation Rubber and the Testing of Rubber" (1920), 45.
6. G. S. WHITBY, l.c.; D. F. TWISS, Ann. Rep. Progr. Appl. Chem. 3 (1918).

gested that in the first coagulation zone the enzyme is the active agent; that in the second liquid zone the enzyme is rendered inactive by the increased acidity of the liquid so that coagulation is inhibited, and that the second coagulation zone represents true coagulation by the acid itself. Now the phenomenon of " irregular series "—systems showing liquid-coagulated zones on the addition of increasing amounts of a coagulant—is well known witn other colloids, and was found to be caused by an unloading of the colloid by electrolytes and a reloading with the opposite sign; and there is no reason to suppose that in the case of Hevea latex this general explanation does not hold.

We have studied and described the " irregular series " for Hevea latex in detail[7]; it can easily be proved that the phenomena are exactly the same when using enzyme-free diluted latex (for instance, latex diluted 1 : 10 and heated to 95°C. to destroy the enzyme). Even the limits of the regions where coagulation takes place are found at practically the same degree of acidity in fresh as in sterilised latex. The phenomenon of the " gap " may therefore be explained in Hevea latex in the same way as with other colloids, and an enzyme does not play a rôle in it.

As an example of experiments in which the facts have not been sufficiently investigated to prove the conclusions drawn from them, we may mention the argument that in latex to which toluol, thymol or chloroform has been added, natural coagulation occurs in the ordinary way. These three substances being well-known bactericides, the conclusion was drawn that natural coagulation takes place in the usual way, even when the bacteria have been killed, so that only the enzyme remained as a possible cause of coagulation. A closer investigation, however, easily shows that in the coagula formed after the addition of the above-named disinfectants, bacteria are not only present but present in about the same amount as in latex not treated with bactericides. Whether the bacteria causing spontaneous coagulation in Hevea latex are resistent to the above-named bactericides, or whether the bactericides are absorbed by the rubber in latex to such an extent as to leave the bacteria unharmed, will have to be investigated further; but the arguments derived from these and similar experiments against the bacterial theory of natural coagulation are valueless. We will come back later to the rôle played in natural coagulation by different agencies.

In the course of our investigations on the coagulation phenomena in Hevea latex, we have tried to elucidate the rôle played by enzymes; our conclusions are as follows :—

The enzyme present in Hevea latex is not able to de-emulsify this liquid; when de-emulsification has been brought about by other agencies, the enzyme may play a rôle in bringing about coalescence. The action of the enzyme is rather slow and by no means indispensable; several agencies bring about coalescence in a much quicker way.

To understand the phenomena occurring in Hevea latex in the course of different coagulating processes, it is well to keep in mind that de-emulsification or flocculation of a lyophilic colloid does

7. O. DE VRIES, Proc. Royal Acad., Amsterdam, January, 1923.

not necessarily mean the formation of a coherent clot; the first and most important change is the de-stabilisation of the colloidal particles, which then may separate individually or undergo a secondary change and unite to a coherent clot. With rubber one is so accustomed to the formation of a clot that the possible existence of a preliminary, flocculent stage is often overlooked; the tendency of the rubber particles to cohere is so large that rubber in powder form is unknown, and that in cases where one actually obtains a flocculate the particles immediately cohere even on light mechanical treatment or on drying. Even spraying the latex after the much discussed new processes does not deliver the rubber in powder form, but practically at once leads to large flakes and a coherent, though loose and spongy mass.

In the liquid state, however, the different stages are clearly discernible. As typical we may mention the following forms of separation :—

1.—Creaming, that is a pure mechanical separation of the rubber particles, rising to the surface of the liquid by force of their smaller specific gravity in much the same way as cream does in milk. This form of separation is obtained, for instance, by keeping ammoniated latex, with or without addition of a suitable disinfectant, for a long time, say, several months or a year. A cream-coloured layer is formed on the surface which contains about 71 per cent. of coagulable rubber. In this layer the rubber globules even after a year and more do not unite (provided surface-evaporation is excluded); under the microscope, in cream diluted with water, each globule is seen to be separate and in Brownian movement, and no smaller or larger flocks are present. This cream has the consistency of a weak paste; in the air it rapidly dries to a sticky film of light yellow rubber. The cream can easily be mixed with water and then gives a perfectly stable liquid, which, of course, differs from the original latex in some respects, for instance in the fact that most of the serum substances from latex are absent. As in dialysed latex, the coagulability of this liquid by alcohol is greatly reduced, but may be restored by the addition of small amounts of electrolytes, for instance, sodium chloride or other salts. Lyophilic colloids according to modern views[8] derive their stability from two factors, viz., electric charge and solvation. In fresh latex the electric charge is evidently so much reduced by the ordinary serum substances that dehydration by alcohol easily destroys the stability and causes separation; but in dialysed latex or in the above described dilution of cream with water, the limit of stability is not so easily reached by the dehydrating influence of alcohol.

As a kind of transition to the next type, we may mention the form of separation obtained by adding a rather large amount of sodium hydroxyde (for instance, 5 per cent.) to fresh, undiluted latex. In the course of 24 hours the rubber separates and rises to the surface in the form of a thick, rather stiff porridge, while a perfectly clear, yellow-brown serum remains. This porridge-like mass remains unchanged for months, and does not show

8. H. R. Kruyt and H. G. van Bungenberg de Jong, Zeitschr. Phys. Chem. 100 (1922), 250.

coherence even after a year; under the microscope, however, it is found to consist not only of unchanged loose rubber globules, but also to contain a certain, though small amount of flocks. Evidently, besides the pure mechanical creaming, the second process, flocculation, has taken place to a slight extent.

The cream obtained from preserved latex and the porridge-like mass described above deserve attention from many points of view. They offer a suitable material for the study of rubber emulsions in water freed from some of the serum constituents; they may perhaps play a rôle in transport as a condensed, and therefore cheaper, form than latex with its 60-70 per cent. of water, and they might perhaps be found suitable for direct application in certain manufacturing processes, although the properties of the rubber have been altered considerably. Of course, the separation of the cream or porridge may be furthered by mechanical means, such as centrifugation, or by chemical means, such as adding certain substances to the mother liquid to increase its specific gravity or decrease its viscosity.

2. Flocculation.—This form of separation is reached by adding to Hevea latex an electrolyte, which unloads the globules to such an extent that the mutual repulsion caused by their electric charge is no longer strong enough to counterbalance the molecular attraction, so that the globules unite as often as their movement brings one into the sphere of attraction of the other. The pure phenomenon of flocculation can, however, only be observed when no agency is present which causes the floccules to coalesce and cohere.

Such flocculates—usually, though wrongly, called " creams " —have been described by several authors. A very suitable form to study their properties is obtained by adding 1 vol. of latex to 9 vol. of water, heated to 90-95° C. On addition of 0.05 per cent. of acetic acid this diluted, sterilised latex, in a short time separates into a clear serum and a supernatant layer of fine flocks of rubber, which do not unite even when kept for several days, though finally, on long standing, the flocks gradually cohere. By shaking, the flocks may be redivided evenly over the liquid, and a latex-like milk is again obtained, but this is not a true re-emulsification; the milky liquid is not stable, and the flocks separate in the course of time; under the microscope the picture is totally different, and the flocculated state is easily detected.

This flocculate is a very easy means of studying the coalescing properties of the enzyme present in Hevea latex and of different coagulants and other bodies[9].

By sterilising latex diluted 1 :2 or 1 :1 in the manner described above, and adding acetic acid, a flocculate may also be obtained; but the flocks only rise very slowly, and it is only on longer standing that a clear serum is seen underneath the layer of flocks. The microscope, however, soon reveals the flocculated state of the apparently unchanged milky liquid.

3. Coagulation or Congealing.—This is the form of separa-

9. O. de Vries, Recueil Travaux Chimiques des Pays Bas 42 (1923), 701.

tion most commonly obtained in Hevea latex; the floccules unite to one coherent clot.

Of these three types of separation the *creaming* represents a reversible change caused purely by gravity; the factors of stability of the globules (electric charge and hydration) are unchanged, and they may be redistributed to a stable emulsion. The enzyme in latex is unable to flocculate or coagulate this cream; this can only be reached by true coagulants.

The *flocculate* is, in the case of Hevea latex, irreversible, evidently because of secondary changes taking place at the same time as flocculation. Stronger coagulants change the flocculate into a coagulum; for instance, large amounts of acetic acid, substances such as alcohol, β-naphthol, thymol chinin, chinosol and others, and strong enzymes, such as papain.

The enzyme in Hevea latex has a remarkable coalescing influence on this flocculate; even so small an amount as 1 part of fresh latex in 250,000 produces coalescence within 24 hours. Especially in latex diluted 1 :10 and heated to 95° C, coalescence can easily be studied; the relation between amount of enzyme (fresh latex) and time in which coalescence is reached can be worked out, and is found to be a rather flat curve; the activating influence of small amounts of acid and the inhibiting effect of larger amounts of acid, the poisoning effect of substances such as copper or mercury salts, and the stimulating effect of small amounts of chloroform and toluol, can be studied; the temperature at which the enzyme is killed can be determined. Besides heating, other methods of killing the enzyme were devised; the enzyme is rendered inactive, for instance, in latex preserved with ammonia, and also in latex to which so much acid is added that the second liquid zone is reached. We hope to publish our investigations on these and other points in another place, and only wish to place on record here that the presence of a coalescing enzyme, which might be called *coalase,* has been proved beyond doubt and that its properties have been studied in many details.

It would lead us too far to discuss in this paper the different experiments which have led us to the above-mentioned conclusion that the enzyme in Hevea latex is not able to bring about the first change which leads to coagulation, viz., the flocculation or de-emulsification, and that it only may take a part in the second change, bringing about coalescence. We will only add a brief description of some coagulation phenomena as they may now be explained in the light of these experiments.

Natural or spontaneous coagulation is initiated by bacteria, which, by decomposition of serum substances, produce the acid necessary to unload the rubber globules. The amount of coagulant produced by bacteria is, however, not sufficient to bring about coalescence, and the enzyme completes the action of the bacteria by forming a coherent clot. Latex heated as described, in which the enzyme and the coagulating bacteria have been killed, undergoes flocculation on infection with bacteria; a porridge is formed, but this porridge does not unite to a clot. On

infection with fresh latex (containing the enzyme) the porridge changes into a clot.

Latex collected from the trees in such a way that infection with bacteria is avoided (latex containing the enzyme, but no bacteria) does not coagulate or flocculate on keeping[10]. Such latex possesses, however, coalescing power on latex already flocculated by a suitable coagulant, and retains this coalescing power, say, for one or two weeks, so that the coalase is not destroyed on keeping such latex.

In ordinary coagulation with a small amount of acetic acid, as generally practised on estates, the globules are flocculated by the acid, but the amount of acid, again, is not sufficient to bring about coalescence, which only slowly follows by the action of the enzyme. Large amounts of acid, however, not only produce flocculation, but also coalescence, so that in such a case coagulation is brought about at once by the acid alone. In such a strongly acid medium the coalase has been rendered inactive, as may be proved by the loss of coalescing power on flocculated latex.

These examples will make it clear that the action of the enzyme is only auxiliary in bringing about the second phase of coagulation, viz., coalescence, in circumstances when the coagulant used to bring about flocculation is not powerful enough to bring about coalescence also. It may be pointed out that, though the enzyme present in Hevea latex is not a coagulating enzyme, but only has the power to coalesce, there are other enzymes which are true coagulating enzymes. Papain, for instance, is able to coagulate Hevea latex without the help of a coagulant; it has such a strong acid-producing action on the serum substances that it causes coagulation even in an alkaline latex[11]. Pepsin, on the other hand, although also a protein-decomposing enzyme, in our experiments was found to have no coagulating effect, and even did not bring about coalescence, so that, at least in Hevea latex, it is less powerful than coalase.

While the coagulation of Hevea latex may be regarded as a problem which, as far as actual estate practice goes, is completely and satisfactorily solved—nothing better than the present methods of coagulation by acetic acid remains to be desired—the way in which coalescence is brought about may be regarded as of primary importance in some of the most prominent problems of to-day, for instance, plasticity. There is no doubt that the serum substances play an important rôle in the hardness of raw rubber. It may already be regarded as proved that all types of rubber containing all the serum substances (sprayed rubber, latex evaporated to dryness in different ways, etc.) are harder, less plastic than ordinary plantation rubber, and consume more energy when being broken down. A rubber which is more plastic and easier to mill, but has the same vulcanising properties as ordinary plantation rubber, is the fervent wish of manufacturers; the problem of the

10. Compare G. Vernet, Bull. des Caoutch., Inst.-Col. de Marseille, 1 (1919), 115.
11. A. J. Ultee, Teysmannia 28 (1917), 179; Bull. Imp. Inst. (London) 16 (1918), 451.

future will be to bring about coalescence in such a way that a plastic rubber with undamaged vulcanising properties results.

DISCUSSION.

The CHAIRMAN: While it is far from my intention to criticise the paper which this distinguished scientist has sent to be read here to-day, I should like to testify to the fact that of the many Dutch scientists who have lent the weight of their brains to every branch of the rubber industry in the East, there is probably no living writer whose works are read with greater avidity by the British planters of the tropics than Dr. de Vries. If there are any of you who would like to ask Dr. van Rossem any questions he would, I know, be willing to answer them.

Mr. QUINCY TUCKER: Can anybody give an accurate description of an enzyme?

Dr. VAN ROSSEM: No, I am afraid I cannot.

Mr. TUCKER: Are they visible under the microscope?

Mr. KAYE: Oh, no.

Mr. TUCKER: They are really there, I suppose?

Dr. VAN ROSSEM: Yes. One cannot say exactly what they are or how they look.

Mr. TUCKER: It is more or less a theory, I suppose?

Dr. VAN ROSSEM: But the idea of enzymes is real in chemistry. Some have been made pure. You have, for instance, pepsine. It has been made purer and purer and it is supposed at least to be a pure compound; it is the enzyme itself. We are practically sure that these enzymes exist.

The CHAIRMAN: I am sure you wish me to express our thanks to Dr. de Vries for his valuable paper and to Dr. van Rossem for reading it.

GOODYEAR'S DISCOVERY IN THE LIGHT OF MODERN RUBBER RESEARCH.

By DR. W. J. KELLY,

Goodyear Tire and Rubber Company, Akron, Ohio, U.S.A.

Mr. CYRIL BAXENDALE, who presided, said: I will now proceed to read the following paper written by Dr. W. J. Kelly, of the Goodyear Tire and Rubber Company, of Akron, Ohio.

To the greater number of present rubber chemists Goodyear's original patent is merely a bit of historical literature, rarely, if ever, consulted or read. However, this patent is really one of the most interesting of publications concerning rubber, not alone on account of its priority, but equally because of the information contained therein. Looking at Goodyear's patent from the present viewpoint, and with regard to what we know to-day concerning the process of vulcanisation with sulphur, it is really surprising to discover how much the inventor really knew of his process. Naturally, it must be admitted that he knew nothing of the theory of the process, but from the practical standpoint he describes in a fairly general way the present-day methods of manufacture.

To discuss briefly the practical applications used by Goodyear, it seems best to begin by stating that most of his work was probably directed to rubberising fabrics and obtaining a coating which would withstand ordinary atmospheric temperature changes and not become sticky in hot weather and brittle in cold. For this purpose the rubber was dissolved in a suitable solvent, and to this solution or dough were added the vulcanising agents and fillers, sulphur, and a lead compound, which were also ground together in the solvent. This mixture was then spread on fabric, dried, and the whole heated to a temperature of 212° to 350°F., until the operator was convinced that it had been properly cured. This is a fairly good description of present-day methods of making the so-called spread goods.

By choosing a suitable fabric the rubber layer could be made thicker and peeled off in the form of a sheet after curing. It is also stated in the patent that sulphur and other ingredients "may be incorporated into the substance of the india-rubber on heated cylinders or calender rolls, by which it may be brought into sheets of any desired thickness." This also is a fairly accurate description of modern practice, and goes to show that, as far as fundamental operations are concerned, the rubber industry has made no change in the course of eighty-five years. It is rather remarkable that Goodyear suggested two mechanical operations which

have not been subject to improvement, in spite of the number of people who have been working on rubber problems since the time of the original discovery of vulcanisation, and which are still the basis of practically all rubber manufacturing.

The method of heating the article being cured is also described very fully. After drying, " the goods are to be subjected to the action of a high degree of artificial heat, which will admit of considerable variation, according to the thickness and previous preparation of the articles to be treated, say from 212° to 350° of Fahrenheit's thermometer, but, for the best effect, approaching as near as may be to 270°." Nowadays we carry out this process with different apparatus, but the basic principle remains the same.

In so far as the compounding of rubber is concerned, there has been an almost complete cycle. In Goodyear's time only the simplest mixtures were used, but as the price of rubber increased other materials were added to cheapen the product. The number and use of these materials increased greatly, but when the price of rubber dropped again it was found that many of the materials had become indispensable, owing to the fact that they imparted to the product certain desirable properties. Those which were used chiefly as cheapeners were gradually eliminated, and now the mixtures used in high-class articles are as simple as they can be made without sacrificing quality.

There are some statements in Goodyear's patent which seem to indicate that he did not attribute the curing of the rubber to any action of the sulphur, but to that of the heat alone. In one place he states that: " I found during my experiments with numerous substances that whatever substance or substances be used in connection with the india-rubber the grand result sought after could not be obtained without the action of a high degree of artificial heat, which is the great agent in my method of curing." In another place the following statement is found: " The leading feature of my invention, and that which chiefly constitutes the substance or essence of its usefulness, is the discovery of the effects produced on india-rubber by the action of artificial heat at a temperature above that to which the fabric would be exposed in ordinary or common use."

Throughout the patent, mention is made of the compound of india-rubber with sulphur alone, or, with sulphur and white lead, but from the above statements, it would seem that Goodyear attributed the change to the effect of heat, and not to any chemical action of the sulphur. On the other hand, he does not mention the effect of heat alone on a mixture of white lead and rubber, and hence it might also be concluded that he did attribute some of the action, at least, to the sulphur.

In view of the fact that, even at present, the theories of vulcanisation are in a rather chaotic condition, it might not be

out of place to compliment Goodyear on his foresight in remaining silent on this particular phase of his process.

A short discussion of present views on vulcanisation will show that, even now, we are almost in the dark as regards what actually takes place, chemically and physically, during the cure.

Since Goodyear's time the rubber chemists have found that suphur, and not heat, is the " great agent " in the process of hot vulcanisation. That the action of the sulphur on the rubber is purely chemical can no longer be denied, and with this statement we practically reach the end of definite knowledge as to what takes place during vulcanisation. The end result is not due alone to the combination of sulphur and rubber, and this is plainly seen when the quality of products, made with mixtures containing accelerators, is compared with that of non-accelerated mixes, or when acetone-extracted rubber is compared with unextracted. It is possible, in such cases, to obtain products with identical co-efficients of vulcanisation and widely different physical properties, or vice versa. To explain this, it has been assumed that heat " depolymerizes " the rubber, and that the different physical properties are due to different degrees of " polymerization." Harries suggested, in an article published shortly before his death, that polymerization was a misnomer, when applied to rubber. His thought was that, when a substance polymerizes, there is a definite shifting of the bonds between certain of the atoms, as in the case of formaldehyde, and hence polymerization is a purely chemical change. In the case of rubber, we have no definite proof that the change is not chemical, but in all work done thus far, the products obtained from " polymerized " and " depolymerized " rubber, by the action of other re-agents, such as chlorine, bromine and ozone, are identical. Therefore, Harries suggested the word agglomeration in place of polymerization, and, from the present views of rubber structure, this is probably more nearly correct.

It is, however, possible to explain the behaviour of rubber in this respect on a physical, or, better, colloidal basis. Before doing this, it will probably be best to investigate the rubber itself from a colloidal viewpoint. The ordinary rubber of commerce is, of course, not a pure substance, but contains two principal " impurities," the resins and the proteins. Thus, instead of having a simple substance to work with, we have a system. From the nature of the two classes of compound, it is probable that the resins are dissolved in the rubber, and the proteins are not, and hence we have a two-phase system, which is one of the necessary conditions for plasticity—and rubber is a plastic. Now. if we remove the resins by extraction with acetone, the physical characteristics of the rubber are not changed in kind, and only slightly in degree. Going farther, let us now remove the proteins by dissolving and filtering the rubber, and then recovering it by precipitation. We now find that the physical characteristics of the product are practically identical with the original material. If we attribute the physical characteristics of the original rubber to the fact that it is a system of two or more phases, does not the same reasoning apply to the

pure rubber hydrocarbon itself? In applying this reasoning, the first question which arises is, what are the two or more phases? Considering, then, first from a chemical standpoint, it is fairly safe to say that they both (or all, if there are more than two) probably have the same empirical formula, viz., $(C_5H_8)x$. The value of x may be different in the different phases, or it may be the same with a different arrangement of the atoms and position of the double bonds. This is entirely possible, when we consider that gutta-percha and balata have the same empirical composition as rubber, yet differ considerably in the degree of their physical characteristics. Thus, when we consider the whole of the rubber, including resins and proteins, we see that we are dealing with a rather complicated system, and one that cannot be separated easily into its component parts. This renders the study of vulcanisation very difficult, but until some progress is made in this direction the true explanation of vulcanisation cannot be given.

Add to the above the action of sulphur, not only on rubber, but also on the resins and proteins, and the subject becomes even more complicated. Vulcanisation with sulphur is the simplest of all, and when we begin to add the other active and inert materials, especially the organic accelerators, we have increased the variables to no mean extent, and hence the complexity of the whole problem.

This much Goodyear contributed to the problems of the modern rubber research chemist by discovering vulcanisation, and, in spite of the years since the original discovery, vulcanisation remains almost as much a mystery as when the process was first carried out.

To return to Goodyear's patent, it is obvious from the statement that, " the greater the proportion of lead in the compound employed, usually the shorter time required to cure it "; that Goodyear was also the first to use and observe the action of an inorganic accelerator. These were the only ones used until the advent of the organic accelerators, about 1910, or, practically seventy years after the discovery of vulcanisation. Since the first use of organic accelerators, the chemistry of rubber has been studied by more men than before. This, taken in connection with the fact that the old days of the " secret process," which was common knowledge in all factories, are past, and rubber problems are discussed more openly than ever before, has led to a wonderful advance in our knowledge. However, there is still a long way to go, and it is the earnest wish of the writer to see more work done along colloidal lines in the effort to explain vulcanisation. By this is meant that all methods which we have at present available should be applied to the solution of this problem. Neither chemistry nor physics alone will solve it, but a combination of the two, with some mathematics, certainly will. In the past, each investigator has considered only one of the two, either chemical or physical, and a real attempt to use the combination is still lacking. Therefore, let all rubber chemists, who are interested in the theoretical aspects of the problem, start thinking

and working, and, if I might make a suggestion, it might be of great benefit to all concerned if there could be an exchange of views by means of letters or conversation before the publication of some of the papers. At any rate, let's all get together and solve this perplexing and very important problem.

DISCUSSION.

The CHAIRMAN: If any questions that may be asked cannot be answered by some erudite member of the audience they will appear in the report of the Conference and will no doubt be dealt with on some future occasion by Dr. Kelly himself.

Mr. QUINCY TUCKER: At some future time I hope we shall have finally settled who is the actual discoverer of vulcanisation, Goodyear, or Hayward, or Hancock.

The CHAIRMAN: I fancy the discovery of the principles of vulcanisation was made almost simultaneously by Goodyear in America and Hancock in England. We have no record of the actual day, but in the same year both men brought out the results of their investigations.

Mr. TUCKER: Hayward, I think, might be considered the veteran, because he discovered the action of sun and sunlight.

The CHAIRMAN: I am only telling the tale as it was told to me. I have no evidence. I was very young at the time the discovery was made!

Mr. FRANK G. SMITH: I think it a most remarkable thing, that while Dr. Kelly concludes his paper by saying he hopes a lot of work will be done along colloidal lines in the effort to explain vulcanisation, during the past two years we have had no less than three new methods of vulcanisation submitted to us. It is very creditable that scientific workers are still trying to improve the methods of vulcanisation. Mr. Peachey has evolved a new process, Dr. Schidrowitz also has a new process, and I believe Mr. Kaye, according to a lecture he recently gave in London, has found he can vulcanise the rubber during the manufacture of his boards. I think it is very satisfactory to find that chemists are investigating these problems and are still bringing out new methods.

The CHAIRMAN: It is not actually solving the problem as to what vulcanisation is. Of course, the great thing is to be able to do it, though we should like to be able to explain it as well.

Mr. KAYE: We find by our system of vulcanisation, or self-vulcanisation, that we increase the strength of the board 20 or more per cent. in the process of making the boards, and in an exceedingly simple manner. By using a very small quantity of the vulcanising material—$\frac{1}{2}$ to $\frac{1}{4}$ per cent.—you can make the board much stronger. It is brought about by using a minute quantity of the material. You have got exceptional conditions there. You have rubber in the freshly thrown-out or coagulated condition. I think I made it clear in my lecture the other day.

The CHAIRMAN: Do I understand that by putting one-half per cent. of latex into your boards you increase the strength by 20

per cent., and by increasing the amount of latex you increase the strength proportionately?

Mr. KAYE: No, it is not that. Suppose I want to make a board with latex, say with anything from 3 to 20 per cent. Besides the latex I add to it a small quantity of vulcanising material, say a certain sulphide a sulphur compound. This may be added to the extent of one-half or even one-quarter per cent. of the weight of the entire material we started with.

The CHAIRMAN: My intention was to ask whether the added strength of your board is relative to the amount of rubber you put in. Supposing 3 per cent. of rubber is added, increasing the strength by 20 per cent. Would more rubber add to the strength?

Mr. KAYE: In one case I made a board out of straw, without any latex, and tested the strength of the board, bringing it out at so many grammes per square millimetre. Then I made it with 3 per cent. of rubber content, and the strength was much greater. I added to a quantity of the same beating a small quantity of the vulcanising material, and the strength went up 20 per cent. over and above that with latex only. This was due to the vulcanising process.

The CHAIRMAN: Are you in a position to explain what vulcanisation is?

Mr. KAYE: What I would suggest is that the Goodyear method is relatively crude compared with what we are striving after now. In those earlier times they were putting in larger quantities of sulphur to get a given state of vulcanisation than we are using in our modern methods. With the aid of accelerators we are able to use much smaller quantities of vulcanising agents.

The CHAIRMAN: But we are no nearer to the actual solving of the problem—What is vulcanisation? We see the effects but we cannot diagnose the cause.

Mr. KAYE: We know that vulcanisation is an increased aggregation of the rubber structure; whether it is produced by sulphur, as such, or by other factors and conditions acting in conjunction with the sulphur we do not know. We know that after vulcanisation it requires greater strength to tear asunder the particles. In these experiments of mine we have the strength of the material itself, partly added to by the rubber, and added to again by vulcanising.

The CHAIRMAN: This brings the business of the Rubber Section of the Conference to a conclusion. I only regret that Mr. Burgess, Chairman of the Rubber Growers' Association, who has cheerfully borne most of the burden and—I will not say "heat," but rather the "chill" of many days—is not present to make these valedictory remarks.

Papers have been read on almost every conceivable subject connected with the details of our great industry by leading authorities of Dutch, French, American, and British nationality. Their publication will furnish a valuable and up-to-date addition

to existing literature on a subject about which there still remains so much to be learned.

Speaking from my experience as a fairly regular attendant at the proceedings of every Conference held in connection with these Exhibitions in Europe and America I venture to say that this one establishes a record in the variety and wealth of matter that has been presented.

I am confident that I shall voice not only the sentiments of the present audience but also those of a great number of people who will read the report of these proceedings in all parts of the world when I tender grateful thanks to those who have contributed papers, to M. Leplae and to Sir Wyndham Dunstan, joint Presidents of the Conferences, and to Mr. Burgess and Mr. Frank Smith, Chairman and Secretary of the Rubber Growers' Association, to whose zeal and collaboration we owe the placing of what I hope and believe will come to be regarded as another sound stepping stone on the road of Progress.

The Congress closed with a vote of thanks to the Chairman.

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